POWER PLANT ENGINEERING

Established Over 32 Years

VOL. XXXII CHICAGO, JUNE 15, 1928 No. 12

Contents of this Issue

Page

Small Textile Plant Uses Pulverized Coal or Oil as Fuel. Illustrated 658

Turbine Water Rates Increase with Age of Unit. Illustrated 661

Automatic Control of Stage Feedwater Heaters. By John M. Drabelle. Illustrated 662

River Raisin Paper Co. Cuts Steam Costs. Illustrated 663

Isolated Makeup System Proves Advantageous. By Allen A. Woodward. Illustrated 666

Performance Data Should Include All Facts 668

Oil Engines Serve Well for Standby Loads. Illustrated 670

Joining Aluminum Bus Bars. By W. E. Warner 672

Reservoir to Impound Coal. Illustrated 672

Reactive Component in A. C. Circuits. By V. E. Johnson. Illustrated 674

Electricity—What It Is and How It Acts. Illustrated 677

Power, Light and Heat for New Schroeder Hotel. Illustrated 680

Plant Design Reaches New Peak at State Line. Illustrated 685

Underground Steam Line at California, Ohio. By W. S. McLeish. Illustrated 688

Letters Direct from the Plant: Procedure in Starting Up a New Generator. Resoldering End Rings of Rotor of Small Motor. Zeolite Is Porous. Chain Links Make Good Straightening Blocks. Illustrated 691

Questions and Answers: Efficiency Varies with Boiler Rating. Steam Engine Operation. Boiler Construction and Efficiency. Refrigerating System Temperatures. Illustrated 694

Editorial Comment: Obsolescence of Power Plant Equipment. Production—Consumption—Teamwork. "For a Period of Five Years After Completion" 696

Centralized Control for Heating Systems. Illustrated 698

Temperature Controller for Automatic Regulation. Illustrated 699

Thermal Unit Designed for Heating or Cooling. Illustrated 699

Pennsylvania Semi-Portable, Single-Stage Compressor. Illustrated 699

Centripact Pulverizer Employs Both Impact and Attrition. Illustrated 700

Portable Welder Driven by Gasoline Engine. Illustrated 700

Safety Lock for Conveying Equipment. Illustrated 701

News Notes 701

Catalog Notes 703

Power Plant Construction News 704

Published on the 1st and 15th of each Month by the

Technical Publishing Co., 53 West Jackson Blvd., Chicago

New York Office, 171 Madison Avenue

Subscription price $2.00 a year in the United States and possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copies 15 cents.

Copyright 1928, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

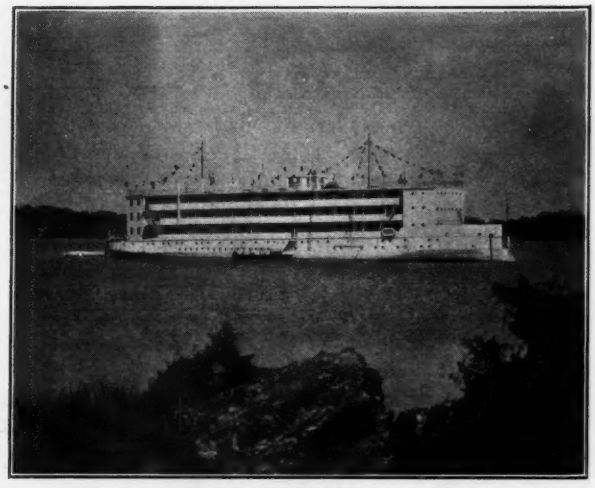
Member, Associated Business Papers, Audit Bureau of Circulations.

Circulation of this Issue 23,450

EDITORIAL STAFF

ARTHUR L. RICE, Editor — R. E. TURNER, Managing Editor — A. W. KRAMER, Associate Editor

CHESTER R. EARLE, Associate Editor — RICHARD H. MORRIS, Associate Editor — EDWARD J. KUNSE, Associate Editor



Once a Warship; Now a Hotel

AMPHITRITE she was and Amphitrite—goddess of the seas—she remains; although serving in a less strenuous capacity and perhaps in a less honorable manner, depending upon her deportment, which we will not discuss, the good ship shown above has been metamorphosed from a time honored fighter which served the United States in two wars, into a floating hotel.

Believing that old warships are too valuable to be scrapped after they have had their share of scrapping, the Marine Hotel Corporation of New York has had this ship changed into a floating hostelry and equipped with all the conveniences and appointments of a modern hotel, even including telephone service available in every one of its 75 thoroughly equipped double rooms, through submarine cable connection with the mainland.

No longer are big guns manned for firing grape shot but "big guns" now come to it to enjoy shots of grape juice and other refreshments. No longer does she move under her own power but now she is towed from port to port as the season requires. After a sojourn in Florida during the winter, she stops at Charleston for a few weeks during the magnolia garden season, then travels on to Old Point Comfort for the naval maneuvers and then to New York for the summer season.

Located in a spot not nearly so wet but far from being in a desert section, a hotel with ten times as many rooms and equipped with all modern conveniences, has been reared and recently opened in Milwaukee. A description of the mechanical equipment of the New Schroeder Hotel with a discussion of some of the problems involved in its design will be found in this issue.

Small Textile Plant Uses Pulverized Coal Or Oil As Fuel

PULVERIZED COAL, OIL BURNING SYSTEM, AUTOMATIC COMBUSTION CONTROL, HIGH-BACK-PRESSURE TURBINE ARE SOME OF THE MODERN FEATURES OF THIS INSTALLATION

AT PASSAIC, NEW JERSEY, in the plant of the Acheson Harden Mfg. Co., a comparatively small textile plant devoted to the manufacture of handkerchiefs, are to be found several features of interest not only because they are very much up to date but also because these features are not ordinarily found in a small plant of this kind.

This is a new plant built last year to replace old equipment which had been in use for many years and which had grown obsolete. This consisted of three 75-kw. slide valve engine driven generating units and four boilers, two of which were Worthington units and two Smith h.r.t. units. These boilers were originally hand fired but several years ago a W. N. Best oil burning system was installed which gave considerable satisfaction.

Since the construction of the new plant, with the exception of the two h.r.t. boilers, none of the old equipment was retained. A new engine room was built and a new 250-kw. Unaflow engine-driven generator installed. The old boiler house was enlarged, the two old Worthington boilers removed and a new Springfield unit put in its place. This boiler is used exclusively now, the two h.r.t. boilers being retained for emergency service only. When they are used they are operated at 125 lb. pressure. The new boiler operates at 185 lb. pressure.

BOILER BURNS EITHER PULVERIZED COAL OR OIL

This new boiler installation is of particular interest because pulverized coal is used as fuel although the arrangement is such that oil may also be burned if desired. A view of this boiler is shown in Fig. 2E, while the unit pulverizer with its combination motor and turbine drive is shown in Fig. 1.

Arrangement of the equipment is beautifully simple as may be noted. The unit pulverizer is located directly in front of the boiler and directly underneath the overhead coal bunkers. Coal is withdrawn from the latter by a traveling weigh larry which makes a permanent record of each charge of coal withdrawn and delivers it to the pulverizer hopper. Pulverized coal is blown through the goose neck feed line directly to the burner which is set in the center of the furnace front.

The boiler which was made by the Springfield Boiler Co. is rated at 201 hp., with 18 ft. tubes set 13 ft. 6 in. above the floor line. It is of the horizontal, cross drum type, with the Foster superheater set between the first and second pass. The boiler is fitted with Diamond soot blowers, Reliance water columns, Wylie Wilson boiler drawoff system, Pratt and Cady stop valves, Golden-Anderson automatic non-return valves, Copes feedwater regulators, Consolidated safety valves, and a Tracyfier. The furnace is 14 ft. 6 in. deep, 6 ft. 3¾ in. wide and an average of about 8½ ft. high. It is lined with General Refractories Co. fire brick. The furnace is faced with white tile brick on front and sides with the single combination oil and pulverized coal burner set about 8 ft. from the floor.

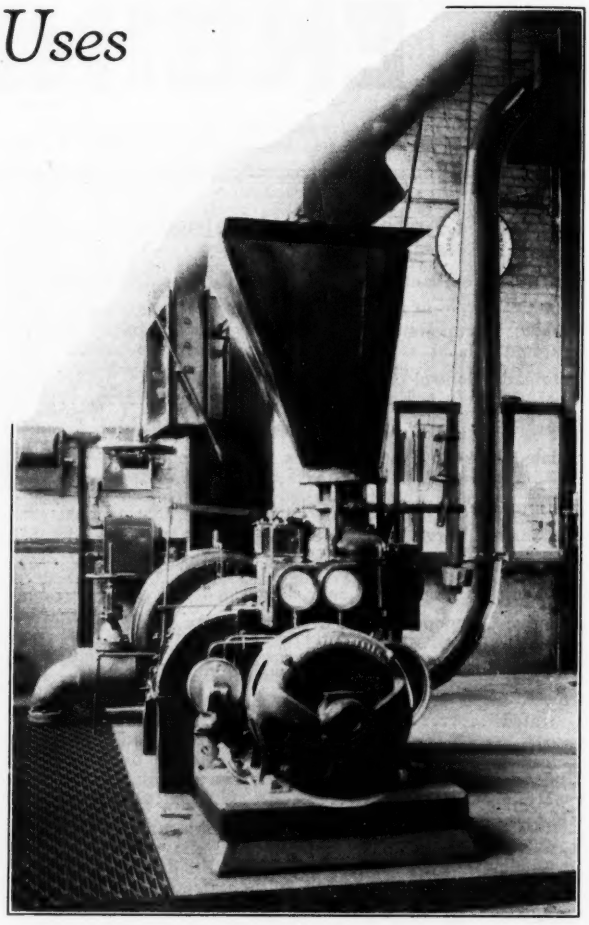


FIG. 1. UNIT PULVERIZER DRIVEN BY BOTH MOTOR AND TURBINE

SUPPLY OF AIR FOR COMBUSTION

Primary air for combustion is obtained from the hollow furnace floor and is fed through a duct leading into the foundation of the unit pulverizer. Secondary air is supplied at the burner. The burner used is an Enco Duplex turbulent burner manufactured by the Engineer Co. It is designed to handle either pulverized coal or oil and is sufficiently large to carry the load on either of these fuels. It is especially convenient in that the oil can be used for lighting off the pulverized coal. Air is supplied through and controlled by dampers placed in the customary manner in an air

Views of the Power Plant at the Acheson Harden Mfg. Co.

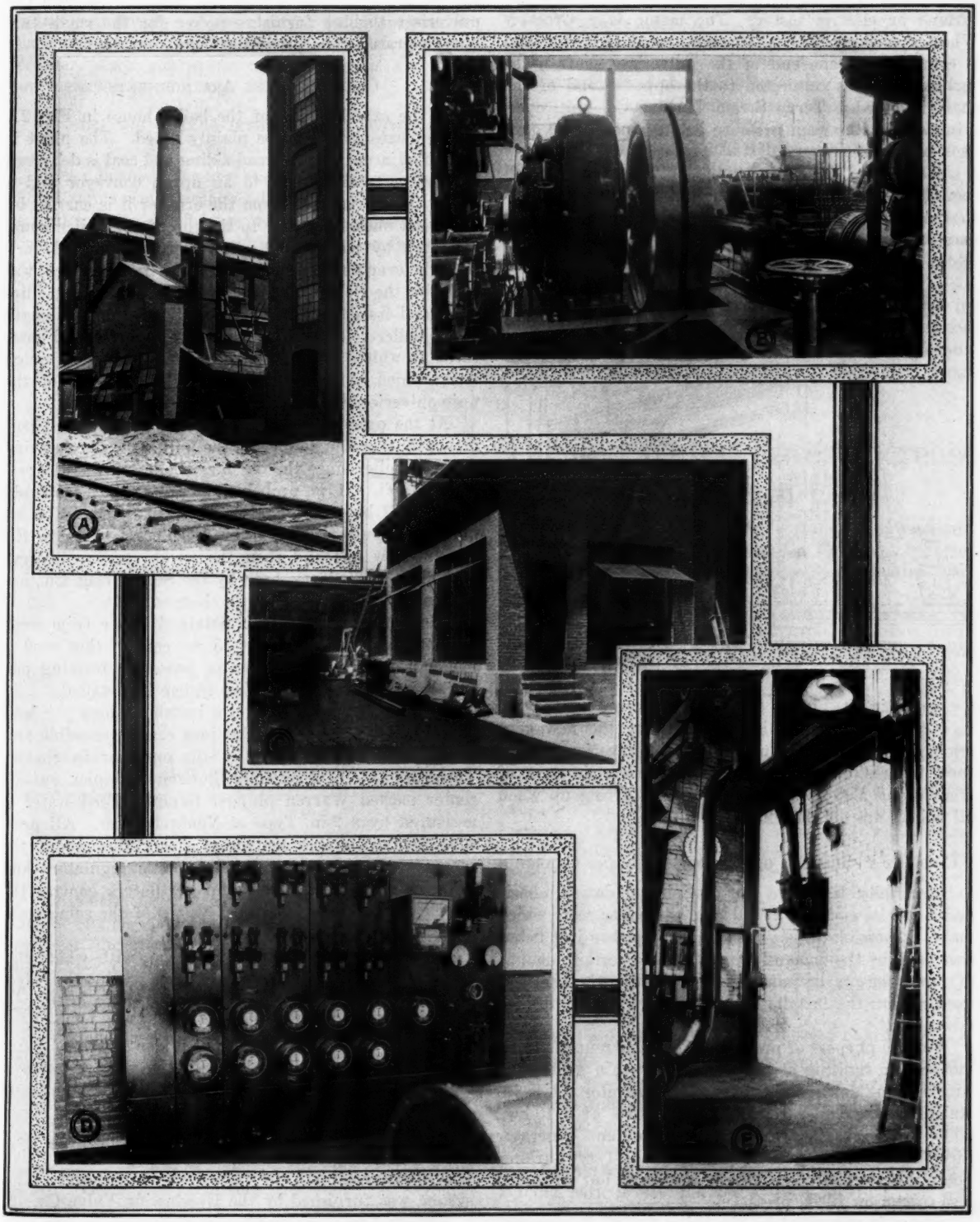


Fig. 2. A. An exterior view of the boiler house, showing the vertical coal elevator. B. Direct current is generated by a Unaflow engine driven generating unit rated at 250 kw. C. The new engine is housed in a new building erected adjacent to the old engine room. D. Switchboard controlling the generation and distribution of direct current. E. The new boiler is fired by means of a combination burner using either pulverized coal or oil.

register in the center of which are located the coal and oil burners.

This boiler is fired by a Type B Aero unit pulverizer operating at 1750 r.p.m. and driven by either a steam turbine or electric motor. The motor is a Crocker-Wheeler machine, 220 v., 70 amp., rated at 30 hp. and is connected to one end of the pulverizer shaft. The turbine which is connected to the opposite end of the shaft is a 30-hp. Terry Steam Turbine Co. unit, operating at 175 lb. steam pressure and against 70 lb. gage back pressure.

The method of operating the pulverizer is interesting. The a.c. motor driving the pulverizer is connected to the lines of the Public Service Co. and with the exception of a small motor generator set is the only

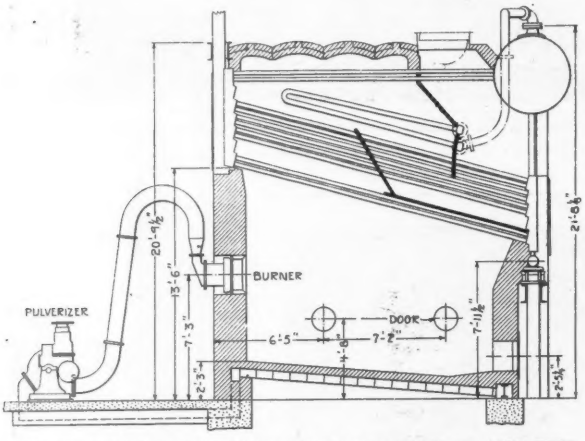


FIG. 3. SECTION THROUGH THE NEW BOILER AND FURNACE SHOWING LOCATION OF PULVERIZER

a.c. motor in the plant. All electric current used in the factory is direct, supplied normally by the new generating unit. The a.c. motor on the pulverizer, therefore, insures an outside source of power in case of trouble and also provides a means of starting up when all boilers are off the line.

Current Purchased on Minimum Demand Charge

Electricity is bought on a minimum demand basis and a special meter is installed in the boiler room which makes it possible to use an amount of power just below that fixed by the demand limit. Since a certain amount of power has to be paid for each month whether it is used or not, the installation of this meter is of decided advantage.

For the purpose of providing direct current for small motors and lighting at times when the main generating unit is shut down, a small turbine-generator set is installed in the boiler room. This consists of a 10-kw., 250-v. General Electric Co. direct current generator direct connected to a 3600-r.p.m. Type ZI Terry turbine, operating normally on 175 lb. pressure but arranged also to run on 70 lb. pressure.

Steam is generated by the boiler at 185 lb. pressure and is delivered to the engine and turbines at that pressure. A certain amount of steam is needed at 70 lb. pressure for the ironing machines in the factory and it is for this reason that the pulverizer turbine operates at the high back pressure mentioned. The 70 lb. exhaust from the pulverizer turbine can also be delivered to the small turbine-generator described in the preceding paragraph, so that when the main engine is shut down and no process steam is required, the exhaust from the pulverizer turbine furnishes power for the small turbine-generator, thus providing direct current.

Coal Handling Arrangements

In the exterior view of the boiler house in Fig. 2A the new extension may be plainly noted. The plant is located adjacent to a railroad siding and coal is delivered through a track hopper to an apron conveyor and a Jeffrey ring crusher. From the crusher it is carried by a vertical bucket elevator to the top of the boiler house and then by means of a screw conveyor carried horizontally over the coal bunkers. The latter which was built by the Scheid Engineering Co., is of steel, elliptical, and lined with Bitumastic. It extends the length of the boiler room and is provided with three coal gates through which coal is delivered to a traveling weigh larry which in turn delivers it to the hopper of the unit pulverizer.

At the present time this weigh larry is located permanently over the hopper of the unit pulverizer serving the new boiler since the old h.r.t. boilers are still operated on oil. It is probable, however, that these old boilers will be removed at some future time to be replaced by pulverized coal fired boilers similar to the present new one and then the weigh larry will serve all boilers. This larry, built by the Scheid Eng. Co., has a capacity of 1000 lb. in two charges.

Water for boiler feed is obtained either from wells or from city mains. About 75 per cent of that used is make-up. Since the raw water has scale forming materials in it, a zeolite treating system is installed.

Two boiler feed pumps are installed along the wall in the boiler room where they are easily accessible and always under observation by the operator in charge. These are 7½ by 5 by 10-in. horizontal duplex outside center packed Warren plunger pumps. Feed water is measured by a 2-in. Type M Venturi meter. All pressure regulation and control of steam throughout the plant is effected by the use of Leslie regulators and reducing valves. Leslie pump regulators control the discharge of pumps and relief valves of the same make are provided on the exhaust line.

The Wylie Wilson drawoff system, with which this boiler is equipped, is an arrangement of a tank, valves and piping whereby the boiler may be blown off slowly. In this system (Fig. 4) the water from the boiler flows into tank which has first been put under pressure. After the tank has been allowed to fill, the valve 2 between the boiler and the tank is closed in still water, the steam connection, 1, between the tank and the boiler closed and a vent, 3, opened to atmosphere, reducing the pressure in the tank to atmospheric. The drawoff valve, 4, is then opened and the water runs to discharge. This system was furnished by the Everlasting Valve Co.

Combustion is automatically controlled by the Carrick system of combustion control. This regulates the primary and secondary air supply, the damper and the rate of coal feed.

With the above described equipment, the boiler is operated normally at from 175 to 250 per cent of rating.

The equipment has been selected so as to have the entire plant as nearly self-operating as possible to make it; in fact, it is designed so that one man can operate it. Operation is watched carefully by means of the following instruments: 3-pen recorder for steam pressure, steam temperature, and rating; CO_2 recorder, feedwater recorder, stack gas pyrometer, draft gage and steam flow meters.

Generating Unit, Auxiliaries and Switching Equipment

Although small, the new engine room is well designed and of ample size to accommodate the new engine-driven generator unit. With large windows on three sides, the room is flooded with daylight and, except on the darkest days, no artificial illumination is needed.

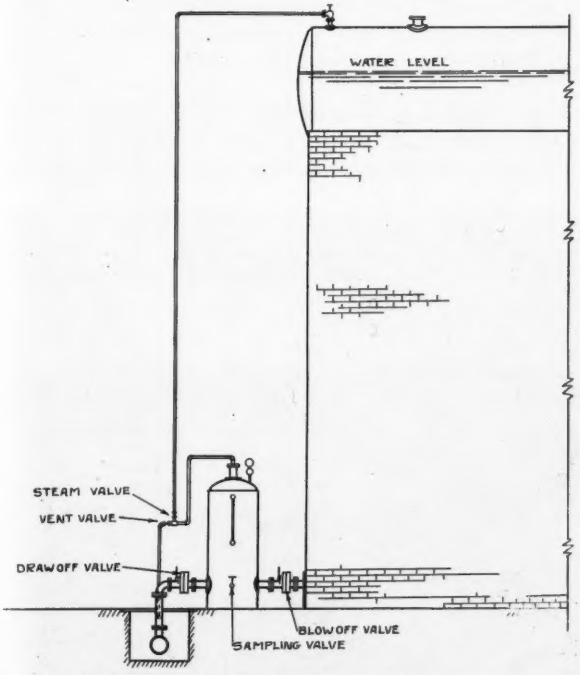


FIG. 4. DIAGRAM SHOWING BOILER DRAWOFF SYSTEM

The generating unit consists of a Skinner Universal Unaflow engine, designed for 185 lb. pressure, 125 deg. superheat, direct connected to a 250-kw., 250-v., 1000-amp., 200-r.p.m. Crocker-Wheeler direct current generator. The engine operates, normally, against a back pressure of 5 lb., exhausting direct into the heating system. An L. B. system of safety stops, furnished by Ludeman Bros., Inc., of New York City, is provided, which fully protects the engine against damage from water in the steam supply. Just above the engine cylinder in the main steam line is a 36-in. receiver. The L. B. system functions instantaneously in case 14 in. of water collects in this receiver, by shutting off the steam supply. The engine is further protected by a centrifugal device on the generator shaft which also trips the same stop valve in case of overspeed. A third control, hand-operated from a point outside the engine room, is provided for use in emergency.

Besides the generating unit, the engine room contains a 6-panel switchboard consisting of 1 d.c. generator panel fitted with Westinghouse air circuit breaker, voltmeter, ammeter, rheostat and field switch; 1 totalizing panel with a Westinghouse recording ammeter and Sangamo watthour meter; 3 feeder panels and 1 blank panel for a future feeder.

Conclusion

For a plant of this small size, using virtually a single boiler, the Acheson-Harden plant is remarkably up-to-date and well equipped. While many of the automatic appliances described and installed in this plant are commonly used in large stations, their use in small plants is not as prevalent as one would like. Labor saving and coal saving equipment are just as valuable in a small plant as in a large plant and it is only because this fact is not generally recognized that such equipment is relatively scarce in plants under 500 hp.

The Acheson Harden Mfg. Co. is to be admired for its modern views in the building of this plant. All construction was done by the plant force under the personal supervision of Harold Buckingham, Mechanical Engineer of the Acheson Harden Mfg. Co.

Turbine Water Rates Increase With Age of Unit

RESULTS of steam rate tests made on several turbines by the Detroit Edison Co. have been reported by the N. E. L. A. Two tests on each machine were tabulated, one being the first recorded test made with the turbine in proper running condition, the second being the most recent test made with the turbine intact, for which complete operating data are available.

TEST RESULTS SHOWING THE AVERAGE ANNUAL INCREASE IN STEAM RATE OF SEVERAL TURBINE UNITS

Plant	Kw. Per Unit	Type	Operating Pres. Lb. Gage	Superheat Deg. F.	Time Yr.	Test Load Kw.	Steam Rate Standard Conditions	Aver. Annual Incr. Lb. Per Kw.-Hr.	Guaranteed Conditions Lb. Per Kw.-Hr.	Aver. Annual Incr. as % of Guarantee
Connors Crk.	20,000	Hor.	230	200	7.8	20,000	11.05 11.16	0.01	11.04	0.13
Connors Crk.	20,000	"	220	200	9.8	15,000 20,000	10.82 11.14	0.03	11.45	.029
Delray	8,000	Vert.	210	170	5.9	7,000	13.32 14.26	0.16	14.0	1.14
Delray	8,000	"	210	170	6.0	7,000	13.26 13.89	0.11	14.0	0.79
Delray	8,000	"	210	170	9.1	7,000	14.30 15.53	0.14	14.0	1.00
Delray	8,000	"	210	170	6.0	7,000	13.70 14.41	0.12	14.0	0.86
Delray	14,000	"	210	170	9.6	10,000	14.59 15.86	0.13	15.6	0.83
Delray	14,000	"	210	170	6.3	10,000	14.50 14.96	0.07	15.6	0.45
Delray	14,000	"	210	170	6.8	10,000	14.94 15.45	0.08	14.5	0.55
Delray	15,000	"	210	170	6.8	15,000	13.44 15.04	0.24	13.55	1.77
Average					7.4			0.11		0.76

In each case, the steam rate given is that at the best point corrected to standard pressure, temperature and back pressure given by the manufacturer's guarantee. During periods between tests, the Conners Creek turbines were rebuilt. For that reason, the average annual increase in steam rate given for these two machines is lower than it normally would have been. Test data for the second unit listed for this station are for different loads, because the most efficient point was changed in rebuilding the unit.

Automatic Control of Stage Feedwater Heaters

METHOD OF CONTROLLING THE TEMPERATURE OF FEEDWATER WHEN EXTRACTION TURBINES ARE ADDED TO OLD PLANT USING OPEN HEATERS. BY JOHN M. DRABELLE*

IN MANY of the older plants that are still in operation, further thermal gain can be accomplished by equipping new turbines, when installed, with one or two stages of steam bleeder heat resulting in an increase in the thermal efficiency of the station as a whole. Such an installation has been made at the Boone and Marshalltown Stations of the Iowa Railway & Light Corp. in connection with two 15-stage 3500-kw. General Electric turbines recently installed and placed in operation. The power plants in question have the ordinary conventional type of open feedwater heaters supplying the boiler feed pumps and taking the steam for feedwater heating from the exhaust of these pumps.

As the station load has increased, the boiler feed pumps do not supply sufficient exhaust steam for heating the feedwater because of the greater demand and the use of more economical turbines for driving them. This resulted in the heat balance of the station being badly upset.

The new turbines were equipped with a stage heater taking its steam from the eleventh stages and the water from the hotwell pump passes through the stage heater and into the open heater. An attempt was made to control the feedwater temperatures by throttling the line between the turbines and the heater with a hand-operated valve. More or less continuous attention was necessary on the part of the operator and, to eliminate this attention, automatic control was devised.

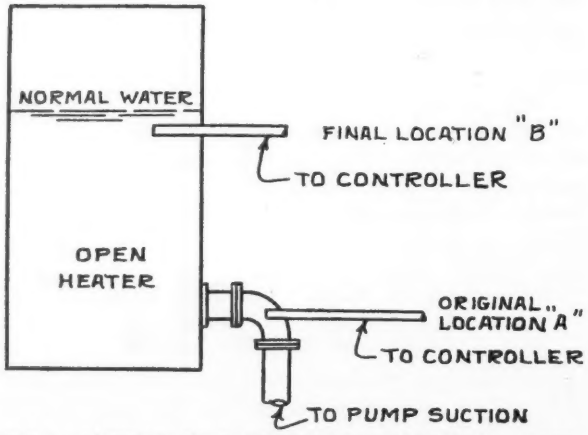


FIG. 1. CONTROLLER GAVE BETTER REGULATION AFTER BEING MOVED FROM "A" TO "B"

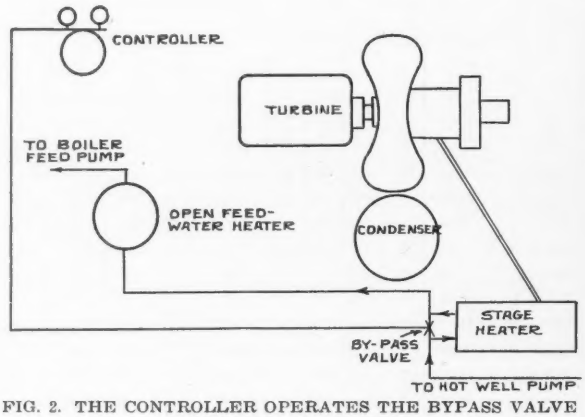


FIG. 2. THE CONTROLLER OPERATES THE BYPASS VALVE AT THE STAGE HEATER

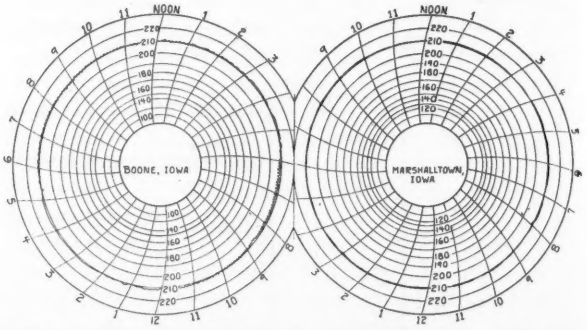


FIG. 3. TYPICAL FEEDWATER TEMPERATURE CHARTS TAKEN FROM THE BOONE AND MARSHALLTOWN STATIONS

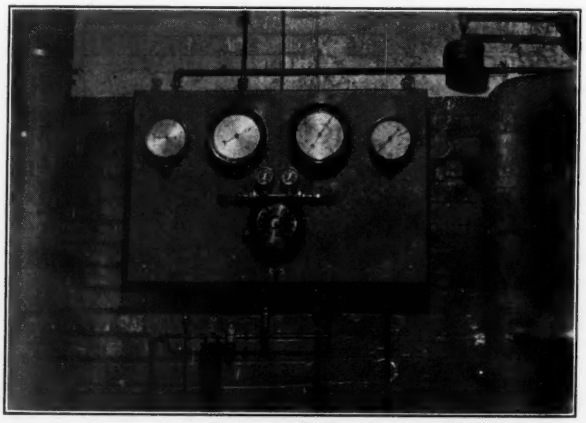


FIG. 4. ALL GAGES ARE MOUNTED WITH THE CONTROLLER ON A CONVENIENT BOARD IN THE PUMP ROOM

Figures 1 and 2 are diagrams of the layout of the system. An air-operated temperature controller, taking its air supply from the station air mains was employed with the bulb of the controller located originally in the line going to the boiler feed pump suction, shown as location "A". Owing to a considerable time lag in water temperature changes, the bulb was relocated to the position marked "B", approximately 4 in. below the normal water level of the open feedwater heater. When installed in this manner, the controller is extremely sensitive to temperature changes in the open feedwater heater.

*Mechanical and Electrical Engineer, Iowa Railway & Light Corp., Cedar Rapids, Iowa.

Across the inlet and outlet of the stage heater is connected a bypass valve. The valve is assembled reversed; that is, when there is no air pressure on the diaphragm of the valve, the valve is open, while with air pressure on the diaphragm, the valve is closed, causing the water from the hotwell pump to flow through the stage heater and then out to the open feedwater heater. When the temperature rises, the air pressure is released from the diaphragm of the valve and the water bypasses the stage heater, going direct to the open heater. In actual practice, the valve is in more or less continuous operation, being in a state of either opening or closing practically all the time. The effect of the operation of the valve, for the Boone Station, is clearly shown in the curve drawing thermometer charts, Fig. 3. In the Marshalltown Station, this effect is not so marked, as Marshalltown runs under a base load. Figure 4 is a photograph showing the controller mounted on a gage board conveniently located in the boiler feed pump room.

This equipment has been in successful operation over a period of nearly a year and there have been no operating difficulties of any kind encountered with it. It has given absolute satisfaction and exact control of feedwater temperatures, with a consequent improvement in the evaporation of the station.

River Raisin Paper Co. Cuts Steam Costs

INSTALLATION OF FOUR MODERN BOILERS FIRED BY UNIT COAL PULVERIZERS REPLACES 25 OLD BOILERS WITH TOTAL CAPACITY OF 5330 HP., REDUCES COAL CONSUMPTION ABOUT 175 T. A DAY AND ELIMINATES 50 ATTENDANTS

REDUCTION of coal consumption of a large paper mill from about 400 t. a day of 24 hr. to between 200 and 250 t., together with a reduction in the boiler room operating force from 65 men to 15 men, at the same time making more steam for the plant under modern operating conditions than was made by the old equipment, are the results accomplished with the boiler house equipment recently installed by the River Raisin Paper Co., Monroe, Mich., makers of solid and corrugated fiber shipping containers. These reductions in operating cost were brought about by removing 13 boilers, hand-fired with shaking grates and 12 chain grate stoker-fired boilers, installed in three separate boiler houses about the property and replacing them with a central boiler house containing three modern water-tube boilers fired with pulverized coal. A fourth similar unit has just been put into service and space is left in the boiler house for the fifth unit.

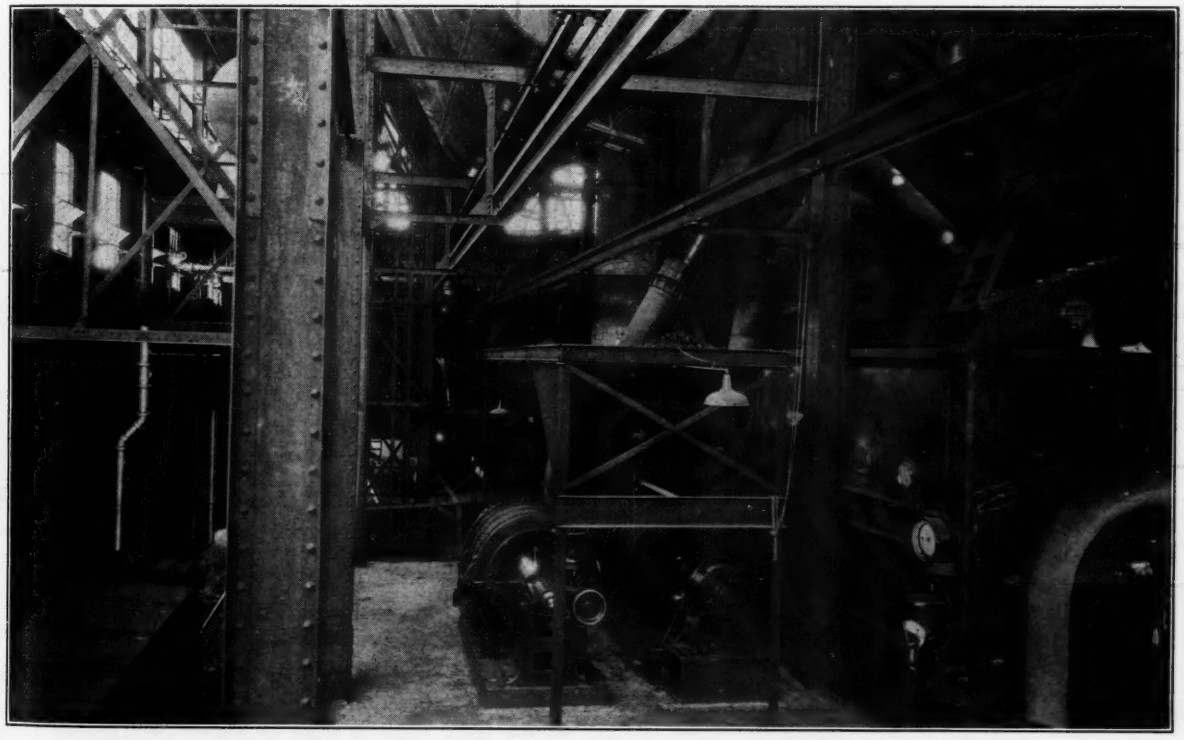


FIG. 1. FIRST THREE BOILER UNITS, NO. 3 IN THE FOREGROUND, SHOWING UNIT PULVERIZERS AND INSTRUMENTS, SKIP HOIST AND COAL BUNKERS

Work of remodeling the plant began in 1925. It was necessary, of course, to maintain operation while the remodeling went on, therefore only a few of the old boilers could be taken out at a time to make room for the new

ones. As is usual in such cases, the work of actually installing the new boilers was only a small part of the job. The power house roof had to be raised 29 ft., piping had to be altered to fit the new units and so on. This work proceeded smoothly under the supervision of Grant E. Miller, chief engineer for the company, who had carried out the entire design for the new plant. In the latter part of 1927, the boiler house interior appeared as shown in Fig. 1, with the first three units in place. Boiler No. 4, which has just been completed and put in service, is at the right of No. 3, which appears in the foreground of Fig. 1.

TABLE I. TYPICAL PERFORMANCE DATA FROM THE NEW BOILERS

		Average B.hp-hr.	Coal per Day, Tons	Total Coal Tons	Lb. Coal per B.hp-hr.	Evaporation
No. 1 Boiler	Under Fire 16 Days					
	11 Work Days	2804	89.77	987.48	2.66	11.28
Mill Not Run	5 Days Down	1430	42.53	212.65	2.48	12.09
	Starting up Coal			6.11		
	16 Days	2374	75.39	1206.24	2.61	11.49
No. 2 Boiler	Under Fire 11 Days					
Mill Running	9 Work Days	2575	82.27	740.48	2.66	11.28
Mill Not Run	2 Days Down	1509	47.69	95.38	2.63	11.40
	Starting up Coal			3.02		
	11 Days	2381	76.26	838.88	2.67	11.23
No. 3 Boiler	Under Fire 24 Days					
Mill Running	22 Work Days	2669	82.39	1834.66	2.60	11.54
Mill Not Run	2 Days Down	1660	49.62	99.24	2.50	12.00
	Starting up Coal			24.58		
	24 Days	2585	81.60	1958.48	2.63	11.40
No. 4 Boiler	Under Fire 20 Days					
Mill Running	20 Work Days	2673	80.44	1608.90	2.55	11.76
	Starting up Coal			21.50		
	Total Coal			1630.40		
Total Av.	20 Work Days	7982	250.41	5008.21	2.62	11.45
	10 Days Down	1864	62.58	625.79	2.80	10.71
	30 Days	5942	187.80	5634.00	2.63	11.40

TABLE II. STEAM AND COAL REPORT, APRIL, 1928, FOR ENTIRE PLANT

		Boiler Horsepower - Day	Night	24 Hrs.	Total Coal Tons	Lb. Coal per B.hp.hr.	Evaporation
1	Sunday	1574	1555	1564	48.36	2.60	11.54
2	Running	7010	6502	6756	212.33	2.62	11.45
3	"	7020	7706	7362	221.14	2.50	12.00
4	"	6396	7863	8129	238.14	2.44	12.29
5	"	7940	7589	7764	237.98	2.45	12.24
6	"	8045	7958	8003	237.79	2.48	12.09
7	Saturday	3774	3270	3522	105.46	2.50	12.00
8	Sunday	1085	1419	1252	40.80	2.72	11.02
9	Running	8102	7472	7787	252.01	2.70	11.11
10	"	7594	8291	7942	249.14	2.62	11.45
11	"	8622	8261	8442	259.95	2.57	11.67
12	"	8570	7941	8256	262.90	2.65	11.32
13	Friday	1278	1153	1215	35.04	2.41	12.45
14	Saturday	1316	1293	1304	40.13	2.57	11.67
15	Sunday	1472	1529	1500	48.29	2.66	11.19
16	Running	7602	7976	7789	245.36	2.62	11.45
17	"	7238	6431	6834	217.41	2.65	11.32
18	"	8310	8217	8263	262.04	2.64	11.36
19	"	8545	8329	8437	275.97	2.72	11.03
20	"	8412	8596	8504	268.50	2.63	11.40
21	Saturday	2530	2124	2327	69.60	2.50	12.00
22	Sunday	2917	2739	2828	102.90	3.03	9.90
23	Running	8990	8474	8732	280.65	2.67	11.24
24	"	8724	8385	8554	270.82	2.62	11.45
25	"	8617	8481	8549	261.06	2.55	11.76
26	"	8408	8266	8336	253.51	2.53	11.86
27	"	8588	8041	8314	256.75	2.57	11.67
28	Saturday	1275	1669	1972	75.15	2.43	12.34
29	Sunday	1168	1153	1160	46.06	2.86	10.58
30	Running	7950	7807	7878	214.76	2.70	11.11
Av. 20 Work Days				7982	250.41	2.62	11.45
10 Days Down				1864	62.58	2.80	10.71
Av. 30 Days				5942	187.80	2.63	11.40
Total Coal 20 Work Days		5008.21T.			30 Days		5634.00T.

Data on Performance of New Plant

In Table I are given typical data on coal consumption and evaporation of these units, as shown by the flow meter charts and coal weights, while Table II is the steam and coal report for April, 1928. Grade of coal burned varies widely, the extent of the variation being somewhat as follows:

Sample	B.t.u.	Ash	Moisture
1	11,300	21.55	1.73
2	10,300	14.00	6.70
3	12,000	7.78	9.10
4	14,500	4.78	1.80

As shown in Fig. 2, the four new boilers are Erie City Iron Works three-drum, bent-tube boilers, each with a heating surface of 12,960 sq. ft. They are designed to generate dry saturated steam at 200 lb. gage; no superheaters are installed. Furnaces, built by Rust Engineering Co., are designed so that boilers can be operated at over 300 per cent of rating when necessary, although under normal conditions they will be operated at about 200 per cent of rating. Each furnace is fired by two Erie City Unitype pulverizers set on the operating floor in front of the boilers. These pulverizers have a capacity of 4000 lb. of coal an hour each and are driven at 900 r.p.m. by Allis-Chalmers 75-hp., 440-v. induction motors.

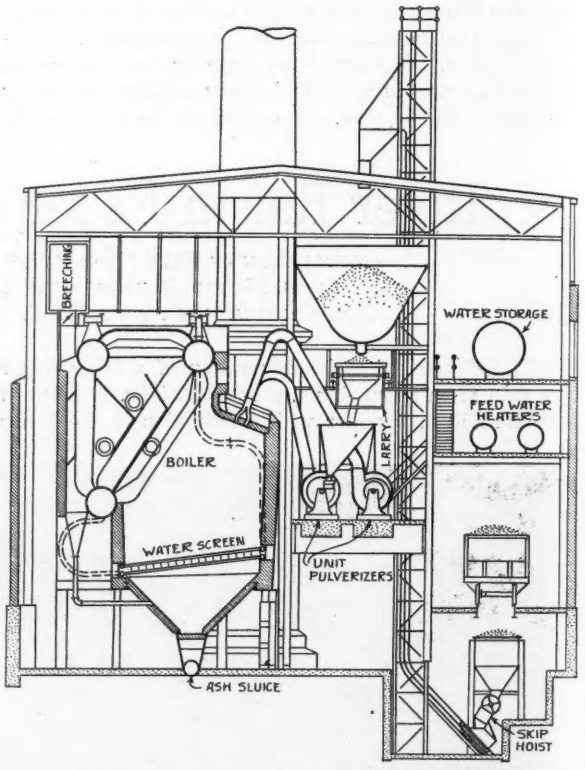


FIG. 2. DETAILS OF BOILER SETTING, WATER SCREEN AND COAL AND ASH HANDLING ARRANGEMENTS

Exchange of Pulverizer Parts Lengthens Their Life

Pulverizers are set so that each mill rotor of one pair rotates in a direction opposite to that of the other mill of the pair. This is done by simply setting the mills end for end. The object of the arrangement is to enable worn paddles and blades to be changed from one mill to the other, thus utilizing both faces of the paddles and doubling their life. Electric Controller & Mfg. Co. automatic compensators with push-button control give the operators rapid and easy control of the mills.

Air supply for combustion is obtained entirely by natural draft. Furnaces are solid refractory with ports in the front wall for admission of secondary air, while some primary air is admitted around the fan-tail burners which fire through the furnace arch as shown.

Most of the primary air, however, constituting about 30 per cent of the total used for combustion, is blown in with the coal by the fan incorporated in each pulverizer.

Each furnace has a Seymour saw-tooth furnace bottom. This consists of two rows of water tubes, one above the other and staggered, with tile laid diagonally from top to bottom tubes. This construction is designed to shade the ash pit from the radiant heat and, at the same time, to reflect a portion of it back to the furnace gas, which reverses its direction just above the saw-tooth bottom.

Two Chimneys Furnish Natural Draft

Natural draft is furnished by two radial brick chimneys, built by H. R. Heinicke Co. One of these is 10 ft.

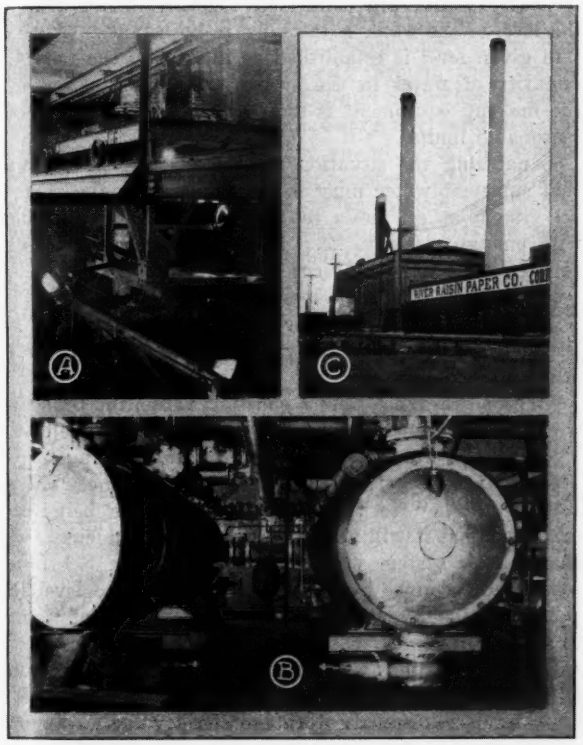


FIG. 3. A — WEIGH LARRY DISTRIBUTES COAL TO PULVERIZER HOPPERS. B—FEEDWATER HEATERS ON GALLERY ABOVE OPERATING FLOOR. C—EXTERIOR OF NEW BOILER PLANT

in diameter and 207 ft. high and the other is 8 ft. in diameter and 209 ft. high. The boiler breeching runs the length of the boiler house behind the boilers, Fig. 2; the 10-ft. stack serves the first three boilers and the 8-ft. stack serves No. 4 unit and will serve No. 5 when it is installed. Suitable dampers are provided in the breeching so that the various boilers can be connected to either stack.

Each boiler front carries an Ashcroft steam pressure gage, a Ranarex CO_2 indicator and recorder, a G.E. (Bailey) recording steam flow meter and a Hays draft gage to guide the operators in operating the units. Boilers are equipped with Reliance water columns, Diamond soot blowers, Lunkenheimer blowoff valves and non-return valves and Consolidated safety valves. Feedwater level is controlled by Copes regulators. Plans are being made for an automatic combustion control system and an installation of recording pyrometers.

Among the interesting features of the new plant are the systems for handling coal and ash. Coal cars are spotted in the track inside the boiler house, over a track hopper feeding a two-roll, 50-t.-per-hr. crusher. Coal passes from the crusher over a magnetic separator; then an apron conveyor feeds it to an automatic skip hoist that carries it up to a small hopper above the roof. From this hopper, two spouts lead in opposite directions to two 250-t. steel storage bunkers in the boiler room. A motor-operated, 2400-lb. weigh larry, Fig. 3A, running the length of the boiler house, distributes coal from the bunkers to the pulverizer hoppers. R. H. Beaumont Co. supplied all coal handling equipment, while the electrical controls and magnetic separator are Cutler-Hammer.

Ash drops through the saw-tooth furnace bottom, noted above, to a hopper, from which it is removed by an Allen-Sherman-Hoff Hydrojet sluiceway. This is arranged so it can discharge to a sump, from which an American Manganese pump can send it to a settling tank outside the plant to be loaded into cars by an Ohio locomotive crane. At the present time, however, ash is being pumped direct from the plant through a 6-in. pipe 1100 ft. long, to fill a marsh near the plant.

Boiler Feedwater Supply

For boiler feedwater, condensate from heating system and paper machines is pumped through a Permutit oil filter and then goes direct to the feedwater heaters. Makeup water is boosted by a 450-g.p.m. Worthington centrifugal pump, driven by an Allis-Chalmers motor and controlled by Mercon pump governors, to a Permutit water softener. From here it goes to two Hoppes, 3000-hp. open heaters, Fig. 3B, one used as standby while the other is operating. For emergency service, in case the 450-g.p.m. booster pump has to be shut down for any reason, the 900-g.p.m. Allis-Chalmers, motor-driven centrifugal pump that supplies water for ash sluicing can be used as a booster.

Boilers are fed by two Worthington, 3-stage, 750-g.p.m., 250-lb. head centrifugal pumps, one driven by an Allis-Chalmers motor, the other by a Kerr two-stage steam turbine. Two 500-g.p.m. Manistee centrifugal pumps and a Worthington 450-g.p.m. pump are installed for general service, while a Pennsylvania motor-driven air compressor supplies air for miscellaneous uses in boiler room, machine shop and in all the mills.

To permit organized research and to co-operate with users of steel castings, a group of eastern foundries has recently formed an association known as the Steel Castings Development Bureau, with an office on the 5th floor, Stock Exchange Bldg., Philadelphia, Pa. George Batty has been appointed research director, assisted by J. V. McCrae, formerly research associate of the Bureau of Standards.

Minnesota Power & Light Co., Duluth, Minn., has authorized a fund of $1,120,400 for extensions and improvements in power plants and system in 1928.

Isolated Makeup System Proves Advantageous

FEEDWATER MAKEUP IS DELIVERED TO THE SYSTEM FROM A SEPARATE BOILER IN THE FORM OF STEAM AT HEADER PRESSURE. BY ALLAN A. WOODWARD*

ONE OF THE PROBLEMS of all steam generating plants is to furnish a supply of suitable make-up water to compensate for the amount lost from the steam cycle during operation. The quantity of makeup required will vary anywhere from 2 to 100 per cent of the boiler feed, while the quality will lie between the limits of distilled water from evaporators and raw water containing unbelievable quantities of dissolved and suspended matter.

For each individual installation, the satisfactory solution is a problem by itself. By far the most general means of adding makeup to the feedwater system is to allow the treated water to mix with the condensate in the feedwater heater or at some convenient point earlier in the cycle. Since the mixture is completed before the water enters the boiler feed pump suction, each boiler receives a quantity of makeup proportional to its evaporation and, in consequence, is subjected to the effects produced by the evaporation of water containing solids in solution.

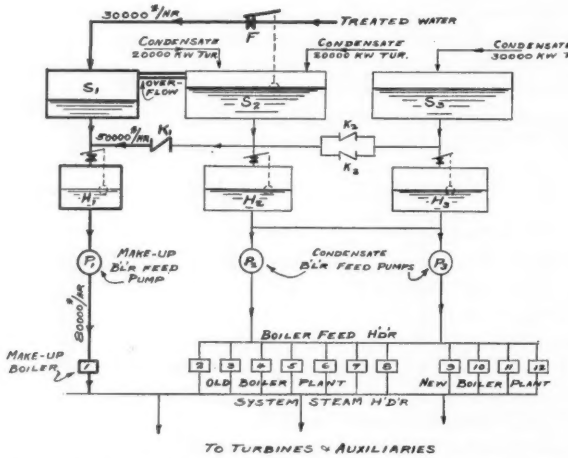


FIG. 1. DIAGRAMMATIC ARRANGEMENT OF THE FEEDWATER SYSTEM OF ACME STATION

In the installation to be described, the makeup water is delivered to the system in the form of steam, at header pressure, generated in an almost isolated group of equipment consisting of a separate boiler, feedwater header, pump, heater and storage reservoir.

A simple diagram of the arrangement of the plant boiler feedwater system is shown by Fig. 1, the heavy outline indicating the makeup equipment. In the interest of clarity, much actual detail is omitted, and all the following descriptive matter will refer to this diagram. Figure 2 gives a single line diagram of the same group of equipment, but shows the complete layout of valves and piping to the various pieces of equipment.

Three surge tanks S-1, S-2, and S-3 are located on the upper balcony of the boiler room, with the feedwater heaters H-1, H-2, and H-3 directly below. Under positive head of 18 ft., the boiler feed pumps receive water from these heaters and pass it through high pressure economizers into 12 boilers, each having approximately 14,500 sq. ft. of heating surface.

Condensate return from two 20,000-kw. turbines is pumped into surge tank S-2, while S-3 receives the condensate from one 30,000-kw. machine. The outlets of these two tanks are connected together, consequently the level of the water is the same in both tanks. A certain given level is established as indicating the normal quantity of water in the system and the function of the makeup equipment is to maintain this level within reasonable limits.

Analyzing the situation more closely, it is evident that sufficient water must be passed through the makeup system at all times to furnish the makeup boiler with enough water to keep it operating at an efficient rating. This particular case calls for about 80,000 lb. per hr. With the plant losses at an average of 30,000 lb. per hr., or about 5.5 per cent of the boiler feed, it becomes necessary to supply the difference from some other source.

If this difference were a constant value, the problem would not be difficult to solve. But this is not the case. The demand for makeup is irregular, varying with every change in station load. A differential check valve K-1 is the key to the solution, this valve being so arranged that it will allow the passage of condensate to the makeup system when the water level in S-1 falls to a predetermined point with relation to the level in S-2. This insures at all times a sufficient flow of water to protect the boiler in case of the failure of the treated water supply, and also adds flexibility to the operation of the boiler. A differential pressure equivalent to 3 ft. of water is required to open the check valve.

ARRANGEMENT AUTOMATICALLY TAKES CARE OF EMERGENCIES

In normal operation the cycle is as follows: During a period of falling station load the quantity of water in the surge tanks S-2 and S-3 decreases temporarily, with a consequent drop in level. The makeup float valve F will then open in an attempt to restore the volume in the condensate surge tanks. The rising water level in S-1 closes the differential check K-1, and stops the flow of 50,000 lb. per hr. of condensate to the makeup heater, which then becomes able to handle 50,000 lb. per hr. more water from the makeup surge tank. The entire quantity of water that is now being evaporated in the makeup boiler comes directly from the makeup surge tank S-1 and this change is usually sufficient to retard the further rising of the water level in S-1 until such time as the output of the makeup boiler has satisfied the demand for additional makeup. The possibility of S-1 frequently overflowing into S-2 is slight provided

*Boiler Room Foreman, Acme Station of The Toledo Edison Co., Toledo, O.

that the float valve F is fairly slow-acting and the surge tank S-1 is of ample capacity.

Now in the opposite case where the system level is rising in the surge tanks S-2 and S-3, the supply of makeup to S-1 is cut off by the closing of the float valve F. When the level in the makeup surge tank has fallen about 3 ft. below that of S-2, the differential check valve then opens and supplies condensate to the makeup system until such time as there is a further demand for makeup.

No system has any place in a modern power plant if it is unable to handle the emergency situations. Let us, therefore, analyze the extreme conditions. If a large quantity of condensate is being lost for an extended period and if the water being added through the makeup boiler is insufficient to meet the requirements, then the continually falling level in S-2 and S-3 will open wide the float valve F, flood the makeup surge tank S-1 and restore the system level through the overflow between the adjoining tanks S-1 and S-2. This, it should be understood, is purely an emergency condition and has no place in the ordinary operation of the system.

On the other hand, when the system water level rises to such a point as to cut off completely the flow of treated water, the level of water in the makeup surge tank is soon lowered to the point where the differential check opens and supplies the full demand of the makeup boiler with condensate. From the foregoing, it will be noted that the makeup equipment functions automatically under extreme conditions. Then, too, should it ever become necessary to revert to the old system of introducing makeup into the condensate surge tank, it is only necessary to close the outlet of the makeup surge tank S-1. The incoming makeup then floods the surge tank S-1 and overflows to S-2 through the connection shown in Fig. 1.

New System Required Little Additional Equipment

In applying to the original plant this new means of introducing makeup into the water system, it was necessary to purchase the surge tank S-1, the 200,000 lb. an hr. open feedwater heater H-1, and the differential check valves, K-1, K-2 and K-3. The original design of the plant called for a 4-in. hydrostatic test line to all boilers and this has fitted into the picture nicely, being now used as a makeup boiler feed header. Fortunately, too, there are available two turbine driven boiler feed pumps of such size as will handle the relatively small quantity of water furnished to the steam generating unit. The extra exhaust steam made available by the use of this additional pump is easily taken care of in the station heat balance. It was felt that a heater was necessary in this system in order to preclude the possibility of the sweating of the economizer tubes, due to the low temperature of the treated water in winter time. The capacity of the makeup surge tank up to the overflow is 25 per cent of the volume of water normally carried in the condensate storage S-2 and S-3.

The differential check valves K-2 and K-3 have never yet been used. They are not weighted and since they oppose each other, the result is the same as if there were no valves at all. In other words, the water level in surge tanks S-2 and S-3 will be equalized at all times. If it ever became desirable, however, to keep the feedwater systems of the two boiler plants—the old and the new—separate, the proper loading of these two valves would permit reasonable differences, such as might easily occur in ordinary operation, to exist between the water levels in S-2 and S-3, yet, under emergency conditions, water from one system would be used to protect the other.

In modern power plant practice, few radical changes in the existing equipment are made, unless it can be shown convincingly that a saving will be effected either in operation or maintenance costs. Wherein, then, does the change above described benefit the earnings statement? Mostly in the matter of boiler room costs. Both the operating and maintenance departments come in for a share of the saving, though the benefits derived by the latter are more tangible. The advantages accruing

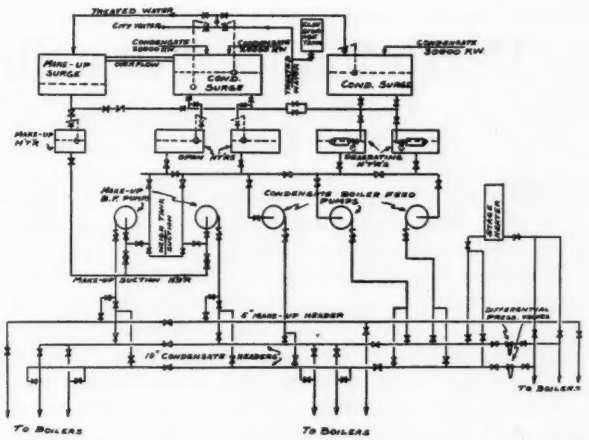


FIG. 2. COMPLETE SINGLE LINE DIAGRAM WITH THE COMPLETE LAYOUT OF VALVES AND PIPING

to the operating department are none the less important, though they cannot be expressed with any degree of accuracy. For example, operating boilers with clean tubes represents an undeniable saving as against a condition where the tubes are coated with $\frac{1}{32}$ in. of scale but the magnitude of the economy can only be estimated.

Almost entire absence of boiler tube trouble is a great help in maintaining the kind of service that is expected of every up and coming public utility, especially during periods when boiler capacity is limited. Freedom from tube trouble also reduces the losses to plant economy which occur when it becomes necessary unexpectedly to bring a cold boiler into service. The amount of heat rejected from the boilers as blowdown has been materially reduced since the operation of the new makeup system. The condensate boilers have been blown once a week instead of five or six times weekly, and a continuous blowdown system is used in connection with the makeup boiler by which the flashed steam is returned to the open feedwater heaters.

It is necessary, however, to blow down the makeup boiler in the usual way about three times a week, in order to get rid of the suspended matter and such particles of scale as become detached from the heating surface. The matter of controlling the concentration of the boiler water means much less work for the operator, as it is necessary only to watch one boiler carefully in-

stead of twelve boilers. The delivery of wet steam from the boilers is reduced to a minimum and slugs of water are now occasioned only by the rare instance of high water in the boilers.

Removing scale from the tubes of a large boiler is rather expensive, aside from the labor cost involved, in that it necessitates the equipment being idle for a period of ten days or two weeks. Although the scale problem in this plant has never been acute, it was found necessary to turbine the boiler tubes at least once every six months previous to the installation of the present make-up system. The first two units of the new boiler installation have been in service for 2 yr. and as yet the quantity of scale in the tubes is almost negligible. It should be clearly understood in this connection that the pollution of the condensate system by condenser leakage must be reduced to a minimum, in order to keep the condensate boilers free from scale. The old schedule of cleaning tubes about every six months will be continued on the makeup boiler. No signs of pitting or corrosion of boiler metal have been noticed, probably due to the fact that all condensate feedwater is deaerated before entering the boiler feed pump.

In conclusion, it is felt that the above described system is desirable because since its installation in July, 1925, it has supplied the requirements of the station during times of normal and emergency operation and it has earned a satisfactory return on the investment cost, due to the economies effected by better heat transfer through boiler tubes, reduction of blowdown heat loss, almost entire absence of boiler tube trouble; the period between tube cleaning has been at least trebled and less maintenance of valves and other equipment has resulted from the evils of wet steam.

Performance Data Should Include All Facts

Comparisons of Various Types of Equipment Are Misleading Unless Complete Facts Regarding Actual Performance Are Accurately Obtained

THERE WAS a time when reciprocating blowing engines were operated either condensing or non-condensing, under conditions which were practically uniform in all blast furnace plants. The small merchant furnace, having no use for considerable quantities of power, in many cases installed non-condensing machines operating against back pressure corresponding with the resistance offered by exhaust pipes of uniform length and size in various plants. Furthermore, steam pressures were fairly well standardized at 100 lb. and, at a little later date, at 150 lb. If the engine was operated condensing, it was well recognized that vacuums above 26 in. would show no gain in economy and it was practically as easy to maintain a 26-in. vacuum as a 25-in. or less. In practically no cases were superheaters provided; consequently, it was not unusual to state the steam rate of an engine without specifying the steam conditions under which it operated.

In more recent years the necessity of providing efficient power plants for steel mills has become recognized and as new power plants have been installed, advantage has been taken of the experience of central stations, resulting in a wide variation of steam conditions existing in various plants. Consequently, today it would be meaningless to state the steam rate of an engine and more particularly of a turbine, without specifying the steam conditions. This error, however, is still made by some who fail to appreciate the effect of steam conditions on the performance of a turbine.

Actual Air Delivered Must Be Known

Twenty years ago practically all air above 1 lb. pressure was provided by displacement blowers or compressors of one form or another; consequently, it was universal practice to rate all blowers in terms of displacement, without any regard for the volumetric efficiency or the actual air delivered to the process by the blower. It was not until the centrifugal compressor was introduced that greater attention was given to the actual air delivered by a blower. It was necessary, before offering blowers of the centrifugal type to the public, to establish some definite means of metering air, otherwise there would have been no way of rating or applying this type of machine. One of the first difficulties in applying the centrifugal machine was due to the purchaser's specifications being based on displacement rating of the positive type of machine, resulting in many cases in the installation of a centrifugal blower from 20 to 25 per cent too large for the job, with consequent inefficiency and surging when operating under customer's light load conditions. Even now this error is sometimes made when specifying blowers or when comparing the performance of the centrifugal blowers with that of other types. In other words, the comparison may be made without having all of the facts.

If we compare the performance of a modern turbo-blower with that of a machine built, say, 12 yr. ago, without having all the facts concerning steam conditions, it will be stated that the steam consumption of the present day blower is only 48.5 per cent of that of the machine built 12 yr. ago. On the other hand, if we have all the facts, 53 per cent of the gain will be due to improved steam conditions and the remainder to improvement in the efficiency of the blower and the turbine.

One of the early arguments offered in favor of the reciprocating blowing tub over the centrifugal blast furnace blower was that by operating the tub at constant speed it would deliver to the furnace constant volume but, as air for the furnace is required for combustion purposes only, the furnace should not be provided with constant volume but rather with constant weight, in order to obtain constant oxygen and constant rate of burning the coke. The effect on the oxygen content of a cubic foot of air varies about 20 per cent with the atmospheric temperature range existing in most localities, and about 6 per cent with variation in barometric pressure and, to some slighter extent, with changes in the moisture content of the air. Consequently, by delivering a constant volume of air to the furnace, there may be an error of between 12 and 15 per cent

too much or too little air as compared with that used under average conditions of 60 deg. F. and 14.7 bar. Therefore, whether blowing the furnace with a tub or a turbine-blower, with such governing mechanisms as exist, it is necessary to operate with volume governors, but to adjust the speed of the tub or the setting of the volume governor at frequent intervals, corresponding with variations in atmospheric conditions at different times of the day. This can be accomplished automatically and experimental mechanisms have been built and tested to show that volume governors may be made into constant weight governors when the operator is ready to accept a more complicated but nevertheless as reliable mechanism as existing volume governors.

In analyzing reports, records and test data, are we always careful to obtain the facts surrounding the information at our disposal? For instance, what does the air flow chart from a blast furnace blower indicate? Usually these charts are provided with pressure and volume pens. In one case a chart may show no variation. In fact, it may have the appearance of having been drawn with a compass. In another case the record line of the volume throughout the 24-hr. period may appear irregular. The blast furnace superintendent may in one case feel that his governing mechanism is operating with entire satisfaction and in another case that the governor on his blower is totally unsatisfactory, but does he stop to analyze the factors which affect a volume governor aside from the design of the mechanism itself?

Governor Affected by Many Influences

It is a well recognized fact that any governing mechanism must have some regulation. In other words, such mechanism will not maintain constant speed or constant flow over a wide range of conditions without changing the speed or the rate of flow. For instance, the governing mechanism on a turbine generator will hold a slightly higher speed at no load than it does at full load. If the governor is adjusted to hold the same speed at no load or full load, it will hunt at all loads, resulting in constant variation in voltage in the generator. The same is true with the volume governor, which may be made to hold the same average volume at light loads as at heavy loads, provided constant swing at the volume above and below the average line would be satisfactory. When a governor is adjusted to hold the same speed at any load, it is said to have narrow regulation. When it is adjusted to hold different speed at light load from that at heavy load, it is said to have wide regulation, and no stable governing is possible unless there is reasonably wide regulation. There are factors which affect the operation of the governor other than actual load. These factors affect the governor in the same manner in which a change in load would affect it, although there may be no actual change in load: For instance, when the volume governor of a turbo-blower is properly adjusted, the error at very light load may be as much as 3 per cent in order to obtain accuracy under normal operating condition. Suppose the pressure of steam supplied to this blower varies widely. This will affect the rate of flow of steam required for the constant air load, resulting in a change of position of levers in the governing mechanism and having the same net result as a change in the volume load itself. The changes in superheat and in vacuum affect the position of levers in a like manner, therefore affecting the regulation.

Regardless of atmospheric conditions, the power required to compress a given volume of inlet air to the blower is not affected theoretically by the density; in other words, atmospheric temperature or pressure have no influence. In a given blower, however, in order to develop the required pressure, it is necessary to change the speed of the blower to compensate for changes in atmospheric temperature and pressure, so by changing the speed, we change the relative load of the blower with respect to its efficiency curve, although the volume and pressure themselves may not be changed; in this way we change the demands on the turbine, which again calls for a readjustment of the link motion in the governing mechanism.

It will be seen, therefore, that in order to analyze properly the performance of a turbine-blower with its governing mechanism we should have not only records of the air pressure and air volume, but also records of steam pressure, steam temperature, vacuum, atmospheric temperature and atmospheric pressure. We must also give consideration to changes in the demands of the furnace, because in a furnace which is in poor condition, requiring considerable checking, with the resulting variations in pressure over a wide range, the effect of governor regulations, which is purposely provided for, must be taken in consideration; and we do not get a true picture of the performance of one machine with its furnace and that of another machine with its furnace unless all of these factors are taken into consideration. In other words, in a plant having constant steam pressure, steam temperature and vacuum, operating in a locality where there is practically no change in the air temperature or pressure and where the furnace is operating in a normally proper condition, we should get a chart of the "compass" variety. On the other hand, if the boiler equipment is in poor condition or the condenser is out of order, or if the chart is taken on a day when there are wide variations in atmospheric conditions, we must expect an irregular volume chart.

Faulty Action of Instruments Affects Readings

Another factor which must always be taken into consideration is that of the recording instrument and the manner in which it is installed. For instance, the instrument itself may have considerable friction, resulting in retarding the motion of the recording pen, or there may be a throttling nozzle between the orifice and the recording instrument. The true picture can be obtained only when all throttling devices are eliminated.

Large sums of money have been spent in developing governing devices for coke oven exhausters, where it is necessary to maintain constant pressure on the ovens in order to obtain the best results with respect to the quality of by-products and the gas itself. All coke ovens are provided with battery governors which are capable of holding close regulation through narrow ranges, consequently it is necessary to supplement these governors with exhausters provided with constant suction governors, which also must hold the suction at the exhauster practically constant. The same factors discussed under constant volume governors apply here, with the exception of the function of the furnace itself.

Oil Engines Serve Well for Standby Loads

LOW STANDBY LOSS, HIGH EFFICIENCY OF OPERATION AND RAPID STARTING ABILITY MAKE OIL ENGINE WELL SUITED AS AUXILIARY IN LARGE STATIONS

NOTEWORTHY among the Diesel installations for standby and peak load service are the plants in Hamburg and Berlin in Germany; in London, England; and in Madrid, Spain. Much skepticism was aroused a few years ago when the 15,000-hp. Diesel installation was made in the Nauhof Station of the Hamburgische Elektr. Werke; but later, the Markische Elektrizitats Werke, notwithstanding its reputation for efficient steam and electrical power production, found it profitable to install two 7500-kw. Diesel engine units for peak load service. This station has been using coal at about $0.65 a ton and oil at 11.7 c. a gallon. The addition of

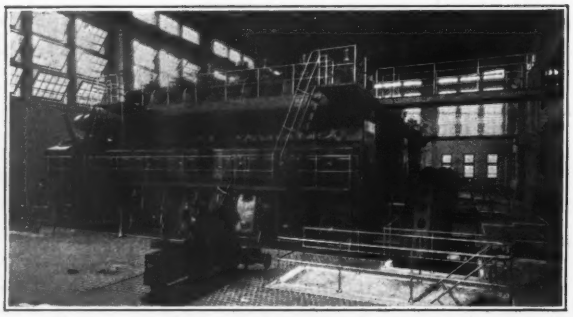


FIG. 1. DIESEL ENGINES TOTALING 12,000-HP. CAN BE PUT INTO SERVICE IN PANAMA IN A FEW MINUTES TIME

the Diesel units for peak load service makes possible an increase of 10 per cent in the station load factor and it is expected the units will pay for themselves in 5 yr. Other large foreign installations that have given good account of themselves in the peak-load and standby fields are the 1200-kw. Diesel installation in the Charing Cross steam station of London and the 4500-hp. installation of the Madrid subway.

In this country, the largest Diesel units for stationary service yet completed are the three six-cylinder, 3750-hp. Nordberg units for the standby service station at the Miraflores station in Panama. The main generating station of the Panama Canal which is located at the Gatun spillway consists of three 3000-kw. generators and one 5000-kw. generator driven by vertical type Pelton-Francis turbines. Necessity for auxiliary power plant is due principally to necessary curtailment of water consumption by the hydro-electric plant during years of extended drought and due to increased water requirements at the locks as business through the Canal increases from year to year.

REASONS FOR SELECTING DIESELS

Originally the Miraflores power plant consisted of three 1500-kw. steam driven generators. As the power demands on this station increased, the capacity of the station was increased by the addition of three similar units for the old Gatun steam plant. When the time arrived to retire these veterans from service, it was decided to substitute oil engine power for steam after different types of prime movers had been considered as follows.

Two 1000-kw. turbine-generators driven by water drawn from Miraflores Lake were first considered. This type of unit lends itself admirably to automatic control and requires relatively small space. During approximately four months of the year, however, Miraflores Lake level is maintained by lockages through the Pedro Miguel Locks from Gatun Lake. It is during this same period that the output at Gatun is curtailed, owing to the need of conserving water and this feature led to the rejection of this type of unit.

Combined hydraulic and steam plant was next considered for this station but since this required the use of a water-driven unit during the rainy season and the use of steam-driven units during the dry season, it was rejected because of the following consideration: The

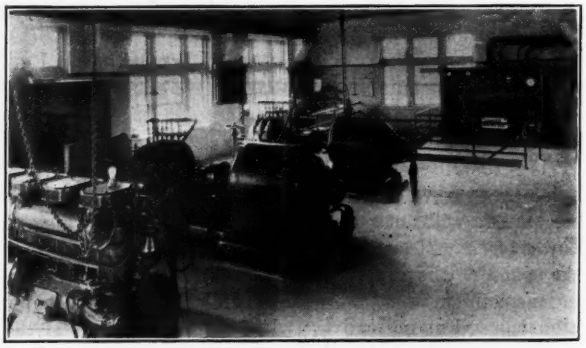


FIG. 2. GASOLINE ENGINE ACTS AS STANDBY SERVICE FOR ELECTRICALLY DRIVEN WATER PUMPING PLANT AT IRONWOOD, MICH., WHICH IS SUPPLIED WITH HYDRO-ELECTRIC CURRENT

primary function of a standby station is to pick up the load immediately after it has been dropped by the main station. For a steam plant to do this, the boiler must always be under sufficient steam pressure to carry the load and since, in order to accomplish this, fuel must be fed continuously, the standby cost is excessive. At the old steam plant, 2 hr. were formerly required to obtain sufficient steam pressure to carry its load, starting from a standstill condition with boilers cold. The cessation of Canal activities for such a length of time was not permissible.

Diesel power inherently overcomes features that are objectionable in other types. While it requires water for cooling purposes, its water consumption in no way compares with that of a water wheel. A Diesel engine may stand idle for months without consuming fuel, but ready to start and carry its full load within a few minutes time.

Distinction should be made between the two classes of service; standby and peak-load, since the degree of importance of several of the factors involved in the

selection of a prime mover varies according to the purpose for which it is intended. Indeed, even for a given service, the degree of importance of any one factor will vary according to a specific case. For example, the need of prompt starting may not be as great in one case as in another.

Factors that must be considered in the selection of a prime mover for standby or peak-load service are: reliability, starting time, standby cost, operating cost, first cost, installation cost, maintenance cost, depreciation, expert attendance and the nature of the average load curve.

Gasoline Engine Merits Place in Standby Field

Reliability probably ranks first in importance for both services but the starting time factor is much more important in the case of standby service than for peak loads. Initial cost and cost of installation of not only the engine itself but all necessary auxiliaries are important factors in standby problems, particularly where the standby plant is likely to be run for only a short time if at all. Under such conditions it is clear that operation cost is a minor consideration. The lower initial cost of gasoline engines together with the higher speeds usually attained by them and the correspondingly lower cost of generators, where they are direct connected, opens a field for this class of internal combustion engine that has considerable possibilities. In fact, gasoline engines as large as 565 hp. are being used for this purpose.

For peak loads, particularly where the load will be carried regularly for a considerable length of time, the operation cost factor may follow in importance that of reliability.

With adequate training and under proper management, operating engineers in other lines may readily become efficient Diesel or gasoline engine operators. The change is simpler than one in the opposite direction and after having been made is usually preferred. It is important, however, to have high grade men in charge of large Diesel plants, because the rate of depreciation is greatly affected by the kind of attention given the engine, as well as by its construction features.

With proper and frequent inspection and immediate attention to small faults before they become serious, life of a modern, well designed Diesel engine compares favorably with that of other prime movers. Diesel engines built 25 yr. ago, during the infancy of the Diesel engine, are still running and producing power at approximately their former efficiency. Long life and sustained economy eliminates the obsolescence charge as applied to Diesels.

Light Loads Should Be Avoided

Internal combustion engines usually operate most efficiently at or near maximum load but the efficiency of a Diesel engine does not vary much between one-half and full load. Below one-half load the efficiency drops rapidly. Moreover, the lubricating oil consumption is practically constant for all loads. In employing Diesels, therefore, for peak-load service, they should be thrown into service when they can carry loads between one-half and full load and the rest of the load distributed among other units that operate efficiently over a wider range. In the case of a hydraulic station, hydraulic power should be utilized until the reservoir is almost depleted when all of the load may be thrown on the Diesel unit or, if several Diesel units are installed, it may be best to have them in different size units so that the unit thrown in at any time will be one that will operate between the limits specified.

Since Diesel engines of a given design operate at about the same efficiency, irrespective of size, the possibility of efficient employment in a given plant of engines of various sizes, including those of small power, presents another advantage over other prime movers. The ability to start easily and quickly adds to the advisability of shutting down one engine and starting another according to the load conditions.

Although the three Sterling gasoline engines which were installed for standby service in case of conflagration in the Municipal Plant at Oklahoma City, Okla.,

FIG. 3. McINTOSH-SEYMOUR 400-HP. DIESEL ENGINE DOES STANDBY DUTY IN WATER POWER PLANT OF NEW RICHMOND ROLLER MILLS CO. AT NEW RICHMOND, WIS.

have never yet been required for that service, timely use is made of them for about an hour during the sprinkling load on summer evenings in order to avoid the expense of firing up an additional boiler during this period.

Otherwise discarded apparatus often serves well as standby or perhaps peak-load service, depending upon the efficiency of operation, because the interest on investment must have been paid or written off as depreciation; therefore, in some cases, as apparatus becomes obsolete it is kept a few years longer for standby purposes. In this manner we sometimes find, as in the case of the Municipal Power Plant of Estherville, Iowa, a steam engine, which was a part of the former steam plant, ready for emergency service in a Diesel plant, notwithstanding it has never been used for such service. Likewise we find Diesel plants serving as standby or peak-load service on high-tension service after the Diesel plant had been purchased by a public service company, as was done at Cherokee, Iowa.

Where Diesels are used for standby service, it is customary to run them for a short time at regular periods, ranging from twice a week to once a month and give them a thorough inspection once a year. At the electric light plant in Logan, Utah, the 775-hp. Nordberg Diesel engine has been required to run only on

three occasions since its installation eight months ago because of minor accidents to the hydro-electric equipment. Here the Diesel operators, who are the regular plant engineers, were trained by the erecting engineer and are kept in practice by running the engine for a short time twice a week, at which time the unit is synchronized with the hydraulic plant.

Electric Interconnection Reduces Standby Need

Interconnection of power systems and the more recent development of co-ordination with private power plants, as well as the offering of special rates for day loads by public service corporations tend to reduce if not eliminate the need for extra peak-load service but in many other power plants the use of the oil engine for standby and peak-load service appears to be increasing, particularly because of its ease and quickness of starting, absence of standby cost, high efficiency and its ability to be synchronized with existing power units of other classes.

Joining Aluminum Bus Bars

By W. E. Warner

WHEN JOINING two metallic bus bars, the resistance of the joint depends largely on the amount the two bars overlap; if the overlap is large compared with the thickness of the bars, the resistance will be nearly equal to the resistance of the two bars in parallel. If the overlap is much reduced, the resistance will be increased, owing to what is known as the distortion of the stream line as the current passes between the two bars. This distortion depends on the ratio of the overlap to the thickness of the bar and is not affected by the width, provided both bars are the same.

If the overlap is 10 times the thickness, the increased resistance due to this distortion is only about four per cent; if the overlap is four times the thickness, the increase is 20 per cent; if only twice the thickness, it is 50 per cent.

Contact resistance depends on the pressure applied to the bars when bolting, the area of the surfaces in contact and the efficiency of the preparation of the two surfaces.

With aluminum, the resistance is greatly affected by the film of oxide which forms on the surface immediately on cleaning. In some experiments, this was overcome by cleaning and bolting the bars under kerosene. This is not possible for everyday work and the best method of preparing is to smear the surfaces to be prepared with vaseline, rough file the surfaces and then bolt together, the dirty vaseline not being wiped off. The presence of the vaseline in the joint has not been found to be objectionable, the majority of it is squeezed out when bolting up. It eliminates the film of oxide which is so troublesome with aluminum. The resistance of joints made by this method were found to be lower than with other methods of preparation.

Where holes are drilled in the bars for the bolting up bolts, these holes should be larger than the bolts and should be bushed with mica or fibre, the screw head and nut should have mica washers, to prevent the screw touching the aluminum. Where aluminum and copper bars have to be joined, both surfaces should be tinned, or a sheet of tinfoil placed between the two bars. As any moisture will cause electrolytic action, the whole joint should be protected by a coat of moisture-proof paint.

Reservoir to Impound Coal

IN HYDRO-ELECTRIC plants, where flow is seasonal, often too great or too small for power requirements, the use of impounding reservoirs to receive water during excess periods and feed it out when needed is common practice. For coal what is needed is a reverse process, so that the flow of coal from the mines may be steady with reservoirs to receive it when power and heating requirements are low and transportation facilities are plentiful, feeding back from the coal reservoirs when demand is large or transportation inadequate.

As an example of one effective provision of storage for surplus, views are shown on page 673 of coal handling and storage system at the Providence, R. I., station of Narragansett Electric Lighting Co. Situated at the head of Narragansett Bay, the plant receives all coal by steamer or barges and coal is unloaded by grab-bucket towers feeding to a belt conveyor system.

Two Procter towers are used, delivering to 42-in. belt feeders which, in turn, deliver to the 36-in. conveyor. The latter runs the full length of the dock and discharges to the coal breaker, where coal is cleaned and crushed to 1½ in.

Thence a 36-in. inclined conveyor, 125 ft. on centers, delivers to the storage conveyor belt which runs 566 ft. through the yard. Coal may be discharged on either side of the trestle by a tripper, which is self-propelling and may distribute automatically over the full length of the conveyor or may be set to discharge at any one point. When coal is needed in the plant, it may be carried by the storage conveyor to a 36-in. belt which discharges to the pulverizing house, where coal is stored, dried and pulverized to pass 200 mesh, then aerated and pumped to the boiler house, 600 ft. distant.

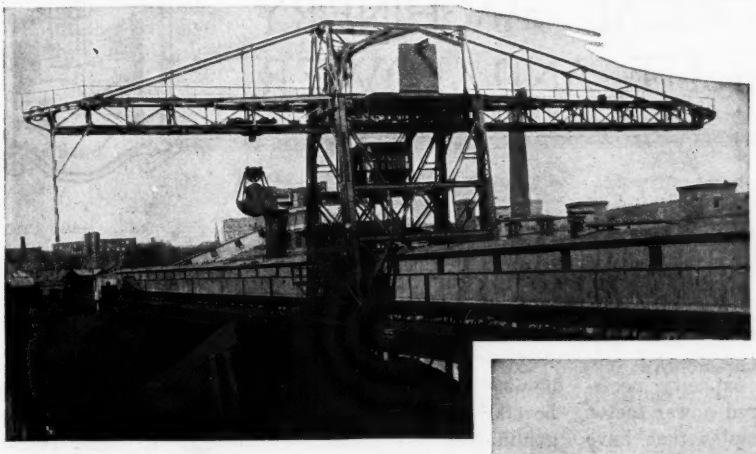
For reclaiming coal from the storage space, which is 90 by 650 ft., a Procter tower with grab buckets delivers to a 42-in. belt feeder loading onto the storage conveyor.

To unload boats, either tower may be used alone and the dock belt conveyor run at 300 ft. a min. to handle 300 t. an hour or both towers may be used, the conveyor running at 600 ft. a min. to handle 600 t. an hour, a 5200-t. steamer having been unloaded and coal distributed to storage in 17 hr. at a cost of less than 5 cents a ton.

Several months operation have proved the satisfactory operation of the system which was installed by John H. Procter & Co., the conveyor and feeders, equipped with Sacon ball-bearing carriers, being furnished by Stephens-Adamson Mfg. Co. to specifications of Jenks & Ballou, consulting engineers. O. S. Richardson was field engineer on the construction and operation is in charge of T. H. Walker, chief engineer, and A. E. Cameron, operating engineer.

Don't be afraid to give some credit to the men under you for their ideas.

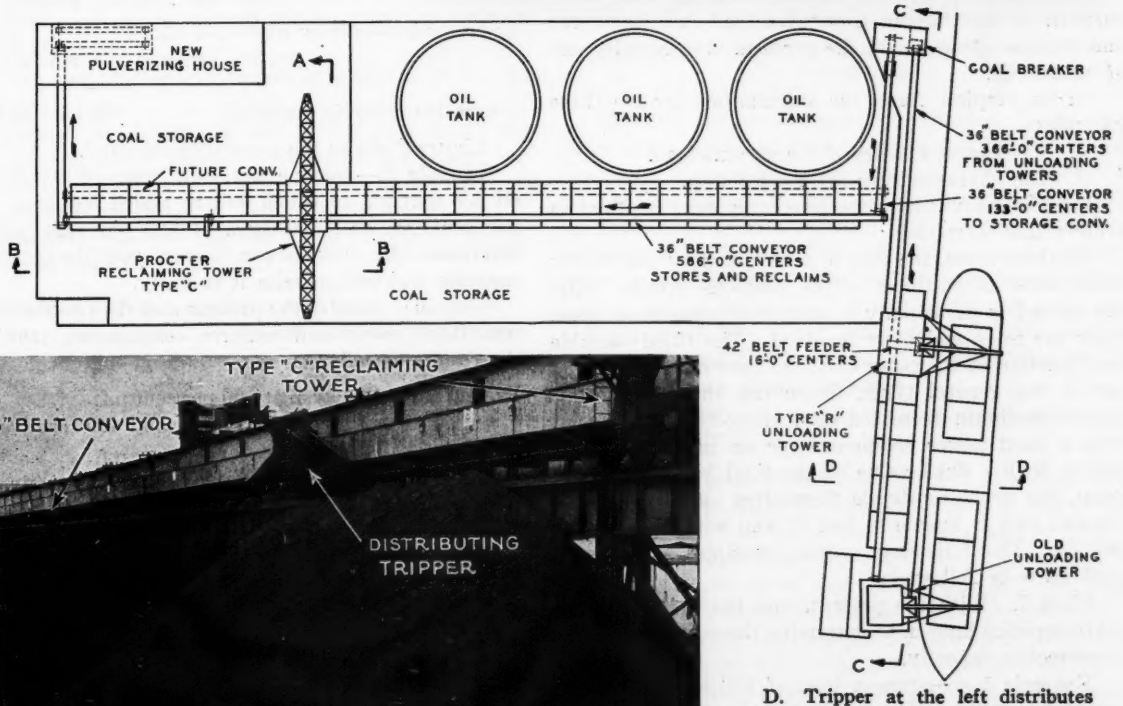
Storing Surplus Coal for 150,000-Kw. Narragansett Plant

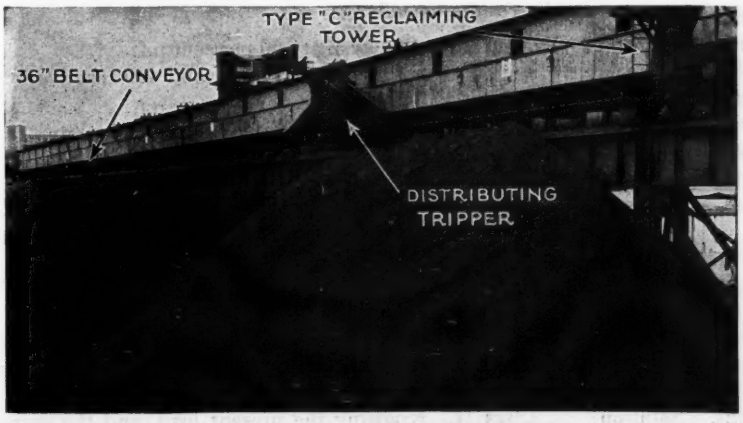


A. Traveling crane at the left reclaims coal from either side, feeding the 36-in. belt conveyor, which runs 566 ft. along the crane runway, discharging to storage at any point in its length by automatic tripper or carrying to the pulverizing house conveyor at the far end.

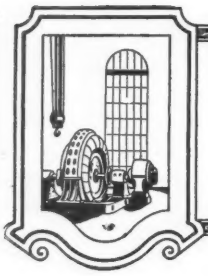
B. Unloading tower at the right delivers from boats to a 36-in. belt conveyor, 366 ft. long, which runs to the coal breaker. This conveyor runs 300 or 600 ft. per min. to serve one or both towers.

C. Plan below gives location of towers, breaker and pulverizer house and of Stephens-Adamson belt conveyor equipment with ball bearing carriers and feeders.





D. Tripper at the left distributes automatically on both sides over the full conveyor length or can be set for any one position.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Reactive Component in A. C. Circuits

PART V. DETERMINATIONS OF THE REQUIRED CORRECTIVE CAPACITY BY ARITHMETICAL AND GRAPHIC METHODS. BY V. E. JOHNSON

CALCULATION OF the corrective capacity necessary to raise a given load to a desired power factor is merely an application of the principles that have already been discussed. Fundamentally, improvement is obtained by cancelling out some or all of the reactive current, so that having resolved a load into its power and wattless components, the problem is essentially one of arithmetic.

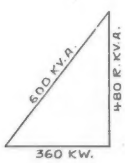


FIG. 1

FIG. 2

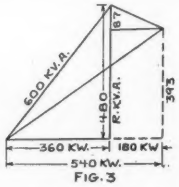


FIG. 3

FIGS. 1-3. GRAPHIC SOLUTIONS OF SIMPLE POWER FACTOR PROBLEMS

In its simplest form, the calculations involve three variables:

A. The characteristics of the present load.

B. The characteristics after correction.

C. The amount of corrective equipment required to achieve this correction.

Of these three, the first is determined by the survey undertaken as outlined in the previous article, while the second is principally a matter of economics based upon the rates and costs involved. The third variable is a function of the other two; the calculations involved are of two general types, depending on whether it is desired to obtain decreased total kilovolt-ampere output with a fixed power component, or an increased power output with a fixed value of the total kv.a. In either event, the problems divide themselves into two general classes: with B known to find C, and with C known to find B. The following typical examples explain the methods to be followed:

Class I. With the present, and the desired future characteristics known, to determine the required amount of corrective capacity.

Example 1.—Assume a load of 600 kv.a. at 60 per cent p.f. lagging. Determine the corrective kv.a. required to raise the power factor to unity, assuming that the power factor output is kept constant. Solution: Resolve the 600 kv.a. into its component parts as follows: At 60 per cent p.f. the power component will be $600 \times 0.60 = 360$ kw. The reactive component will be $600^2 - 360^2 = 480$ reactive kv.a. Figure 1 shows graphically the quantities involved. In order to raise the power factor to unity, the reactive component must be reduced to zero by the addition of an equivalent leading capacity. It is evident that it will require 480 leading reactive kv.a. and that after correction 240 kw. at unity power factor may be added without increasing the original kilovolt-ampere output.

Example 2.—What corrective capacity is required to raise the above load to 90 per cent power factor?

Solution: Resolve the present and future loads into their components and tabulate as follows:

Present load—600 kv.a. at 60 per cent p.f.
= 360 kw. and 480 reactive kv.a.

Desired load—360 kw. at 90 per cent p.f.
= 360 kw. and 174 reactive kv.a.

Corrective capacity required 306 leading kv.a.

Figure 2 shows the quantities involved.

Example 3.—Assume a present load of 600 kv.a. at 60 per cent p.f. to which will be added 500 kv.a. at 80 per cent p.f. and 300 kv.a. at 100 per cent p.f. To determine the new power factor and the corrective capacity required to raise it to unity.

Solution: Resolve the present and the proposed loads into their power and reactive components, tabulating the results as follows:

Present load 600 kv.a. at 60 per cent p.f.
= 360 kw. and 480 reactive kv.a.

Added load 500 kv.a. at 80 per cent p.f.
= 400 kw. and 300 reactive kv.a.

Added load 300 kv.a. at 100 per cent p.f.
= 300 kw. and 000 reactive kv.a.

Total load 1060 kw. and 780 reactive kv.a.

Resultant kv.a. $\sqrt{1060^2 + 780^2} = 1316$ kv.a.

Resultant power factor $1060 \div 1316 = 80.5$ per cent.

The addition of 780 kv.a. at zero per cent leading power factor will "cancel out" the lagging reactive component and raise the power factor to unity.

Class II. Knowing the present load, and the corrective kv.a. to be added, determine the resultant power factor.

Example 1.—Assume a load of 600 kv.a. at 60 per cent lagging power factor. To determine the power factor which will result from adding 200 kv.a. at 90 per cent power factor lagging.

Solution: Resolve the two loads into their components and tabulate as follows:

Present load 600 kv.a. at 60 per cent p.f.
= 360 kw. and 480 reactive kv.a.

Added load 200 kv.a. at 90 per cent p.f.
= 180 kw. and 87 reactive kv.a.

Total load 540 kw. and 567 reactive kv.a.

Resultant kv.a. $\sqrt{540^2 + 567^2} = 784$.

Resultant power factor = 540 ÷ 784 = 69 per cent.

Example 2.—Assume a load of 600 kv.a. at 60 per cent lagging power factor. Determine the power factor which will result from adding 200 kv.a. at 90 per cent power factor leading.

Solution: Resolve the two loads into their components and tabulate as follows:

Present load 600 kv.a. at 60 per cent p.f.
= 360 kw. and 480 reactive kv.a.

Added load 200 kv.a. at 90 per cent p.f.
= 180 kw. and 87 reactive kv.a.

Total load 540 kw. and 393 reactive kv.a.

The total load so obtained differs from that in Example 1 above only in that in this case the total reactive kv.a. is the difference between the components of the two loads, this being due to the fact that they are in the opposite direction, as will appear from the diagram in Fig. 3.

The power factor will be $540 \div \sqrt{540^2 + 393^2} = 81$ per cent.

Example 3.—Assume a load of 600 kv.a. at 60 per cent lagging power factor. Determine the power factor which will result from the addition of 200 kv.a. at zero power factor leading.

Solution: Resolve the two loads into their components and tabulate as follows:

Present load 600 kv.a. at 60 per cent p.f.
= 360 kw. and 480 reactive kv.a.

Added load 200 kv.a. at 0 per cent p.f.
= 000 kw. and 200 reactive kv.a.

Total load 360 kw. and 280 reactive kv.a.

Here, again, the difference between the reactive components was taken, for in the original load the power factor was lagging, while in the added load it was leading.

Resultant kv.a. $\sqrt{360^2 + 280^2} = 456$.

Resultant power factor 360 ÷ 456 = 79 per cent.

In problems as simple as those in the preceding examples, a graphic solution is of no great practical value, as the labor involved in making an accurate diagram is greater than that necessary to solve by mathematical formulas. It is, however, useful in keeping the phase relations clearly in mind, and also serves as a "tabloid reminder" of the correct formula to use.

If the results obtained by graphic methods are to be even approximately correct, the diagrams must be comparatively large so as to minimize the effect of unavoidable inaccuracies in linear and angular measurements. An engineer's scale marked in tenths and hundredths should be used and the angles laid off with a chord scale or an accurate protractor.

Graphic Solution of the Two General Problems

Figure 4 shows the solution of a typical problem by the graphic method. Each load must be drawn with proper angular and linear dimensions, the steps in this particular example being as follows:

Assume that it is desired to show graphically the phase relations in a load composed of 100 kw. at 80 per cent p.f., 150 kw. at 70 per cent p.f., 200 kw. at 50 per cent p.f. all lagging, to which has been added a synchronous motor of 100 kv.a. at zero power factor leading.

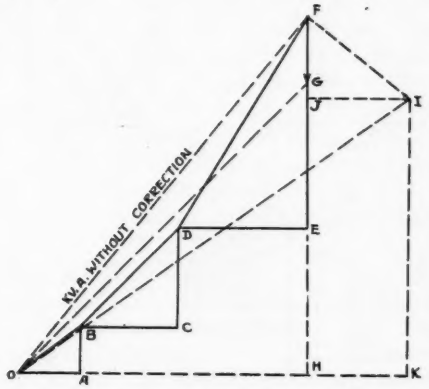


FIG. 4. GRAPHIC SOLUTION OF A MORE COMPLEX PROBLEM

Choosing the horizontal axis as kilowatt "direction," draw the line OA to scale to represent 100 kw. and at the point A erect a perpendicular. The angle of lag for this portion of the load will be that having a cosine of 0.80 which from a table of trigonometric functions, is found to be 37 deg. The line OB is therefore drawn at an angle BOA of 37 deg., to meet the perpendicular from A at the point B. For this particular load, then, OA represents the power component, AB the wattless component, and OB the total kv.a. From this the following relations should be noted:

Cosine angle BOA = OA ÷ OB = power factor.

$OB = \sqrt{(AB)^2 + (OA)^2}$

From the point B and parallel to the line OA, draw the line BC to scale to represent 150 kw., the second portion of the load under consideration, and on C erect a perpendicular. This perpendicular is intersected by a line BD drawn at an angle DBC with BC, this angle being 45 deg. 30 min., corresponding to a cosine 0.70.

The following relations should be noted: BC = the power component. CD = the wattless component. BD = the kv.a. for this portion of the load. BC ÷ BD = the power factor and is the cosine of the angle DBC.

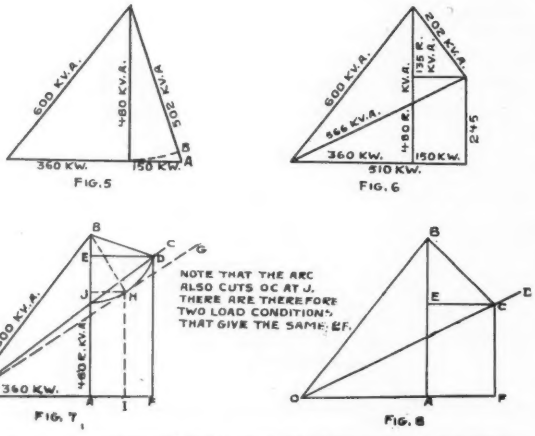
From the point D draw a line parallel to OA, and then draw DE to scale to represent 200 kv.a., making the angle EDF 60 deg., corresponding to the power factor of 0.50.

The following relations should be noted: DE = the power component. EF = the wattless component. DF = the kv.a. for this portion of the load. DE ÷ DF = the power factor, and is the cosine of the angle EDF.

From the point E, and perpendicular to OA (extended) draw FG to scale to represent 100 kv.a. The following relations should be noted:

FG is drawn in a sense opposite that of FE, CD and AB, for the latter three represent lagging reactive components, while FG is leading. There is no power component for the synchronous motor; the power factor therefore becomes zero ÷ FG = zero, which corresponds to an angle of 90 deg.

The final resultant load after the addition of the synchronous motor, has a power component OH, a wattless component HG, a total kv.a. OG and a power factor OH ÷ OG.



FIGS. 5-8. FURTHER GRAPHIC SOLUTIONS OF POWER FACTOR PROBLEMS

If the problem, instead of giving the corrective kv.a., had specified the characteristics which were to be attained by its addition, the procedure would have been exactly as before up to the point where the line EF was drawn. The line OG would then have been drawn at an angle GOH corresponding to the desired power factor, and the corrective kv.a. measured from F to G.

If the synchronous motor had operated at some power factor other than zero per cent leading, there would have been a power component. For example, if it had carried its load at 80 per cent leading, the condition would have been as represented by the dotted lines FI, IJ and OI. The power component IJ is equal to $0.80 \times 200 = 160$ kw. and is drawn parallel to OH. FJ is the wattless component, and the final kv.a. is represented by OI, which in turn is resolvable into the wattless component IK and the power component OK. The final power factor becomes OK ÷ OI.

Correction by Means of Loaded Synchronous Motors

Calculation of the corrective effect of synchronous motors carrying mechanical load and therefore operating at other than zero power factor, has already been briefly touched upon. This is perhaps the most common method of improving operating conditions, being particularly desirable because it reduces investment charges, and also eliminates extra corrective units, with a corresponding saving in losses, space and attendance.

Problems to be solved come under the two general classes already discussed, but there are some special aspects that require consideration. These are closely related to the solutions that have been given, and are fundamentally governed by the same principles.

Example 1.—Assume that a certain load requires 200 kv.a. leading corrective effect in order to attain a desired new power factor. Determine the rating necessary to carry a mechanical load of 50 kw.

Solution: This problem is covered by the graphic solution in Fig. 4. The synchronous motor must be capable of carrying $\sqrt{200^2 + 50^2} = 225$ kv.a. It should be noted that the addition of the mechanical load has an effect on the final power factor. In Fig. 4, it was changed from OH ÷ OG to OK ÷ OI.

Example 2.—Assume a present load of 600 kv.a. at 60 per cent power factor. Determine the rating of a synchronous motor necessary to raise this to unity, and at the same time carry a mechanical load of 150 kw.

Solution: The present load can be resolved into power and wattless components of 360 kw. and 480 kv.a., respectively. The synchronous motor will have to carry $\sqrt{150^2 + 480^2} = 502$ kv.a. in order to raise the power factor to 100 per cent. It should be noted that a comparatively small increase in the motor kv.a. permits the carrying of considerable mechanical load. This is more readily understood by referring to the diagram in Fig. 5, where the additional capacity required is indicated by the line AB.

Example 3.—Assume a present load of 600 kv.a. at 60 per cent power factor. Determine the rating of a synchronous motor required to raise this to 90 per cent and at the same time carry a mechanical load of 150 kw.

Solution: Resolve the present load into components of 360 kw. and 480 reactive kv.a. The addition of 150-kw. motor load will increase the kilowatts to 510, which at 90 per cent p.f. will equal 566 kv.a. The reactive component of this final load will be $\sqrt{566^2 - 510^2} = 245$ kv.a. The corrective kv.a. will be $480 - 245 = 135$, and the motor rating $\sqrt{150^2 + 135^2} = 202$ kv.a. Figure 6 shows the relations of the various quantities.

In the above two problems, the motor or condenser rating has been the unknown quantity—to be determined on the basis of the present and the desired characteristics of the load. It often happens that the rating of the condenser is determined by other considerations so that the corrective effect becomes the unknown quantity.

Example 4.—Assume a present load of 600 kv.a. at 60 per cent power factor. Determine the corrective effect of a 200-kv.a. synchronous motor carrying 100 kw. mechanical load (operating at 50 per cent p.f.).

Solution: Tabulate the components as follows:

Present load	600 kv.a. at 60 per cent p.f. = 360 kw. and 480 reactive kv.a.
Added load	200 kv.a. at 50 per cent p.f. = 100 kw. and 173 reactive kv.a.
Total load	460 kw. and 307 reactive kv.a.

Resultant kv.a. $\sqrt{460^2 + 307^2} = 553$.
Resultant power factor 460 ÷ 553 = 83 per cent.

Example 5.—Assume a present load of 600 kv.a. at 60 per cent power factor. Determine what mechanical load may be carried while raising the power factor to 80 per cent, using a 200-kv.a. synchronous motor.

Solution: This problem can be most easily solved graphically. The present load of 600 kv.a. at 60 per cent p.f. = 360 kw. and 480 reactive kv.a. Draw OA (Fig. 7) equal to the 360 kw. and AB equal to the 480 reactive kv.a. The angle BOA is 53 deg. corresponding to a cosine of 0.60. Draw OC to make an angle COA of 37 deg. corresponding to a cosine of 0.80 (the desired power factor). From B as a center with 200 kv.a. as a radius, draw an arc intersecting OC at D. Draw DE parallel to OA, intersecting AB at E. The length of ED represents graphically the mechanical load which may be carried and still obtain a final power factor of 80 per cent.

The significance of the various portions of the diagram in Fig. 7 is shown by the following tabulation:

OA is the present kw.

OF is the total kw. after the motor load has been added.

OB is the present total kv.a. load.

OD is the total kv.a. after the motor load has been added.

AB is the present reactive component.

AE = DF is the reactive component after the motor has been added.

DE is the mechanical load which the motor can carry with total power factor of 80 per cent.

OA ÷ OB is the present power factor.

OF ÷ OD is the power factor (80 per cent) after the motor has been added.

ED ÷ BD is the power factor of the motor. It is leading.

BE is the corrective reactive kv.a. supplied by the motor.

BD is the kv.a. capacity of the motor.

Maximum correction is obtainable when the radius is in the position BH so that the kv.a. line is tangent to the arc. This is indicated by the dotted line OG, giving an angular displacement of GOF. It will be seen, too, that the addition of mechanical load actually improves the power factor.

At this point of maximum correction, the power factor is equal to OI ÷ OH. Substituting for these values, we get: OI = present kw., OA + motor kw., AI. $OH = \sqrt{OB^2 - BH^2}$. OB is the present kv.a. and BH the rated motor kv.a. It should be noted that the arc with radius BD intersects the line OC at two points, indicating that there are two mechanical loads that will give the same final power factor.

In selecting a synchronous motor for a specific drive it is sometimes purchased on the basis of equal reactive and power components so that its operating power factor will be 70.7 per cent.

Example: Assume a present load of 600 kv.a. at 60 per cent power factor. Determine the size of the synchronous motor required to raise the power factor to 90 per cent, on the basis of equal power and reactive components.

Solution: This problem can be most easily solved graphically. The present load is resolved into its components of 360 kw. and 480 reactive kv.a. Draw OA (Fig. 8) equal to 360 kw. and AB equal to 480 kv.a. Then OB represents the present load in kv.a. Draw BC at an angle of 45 deg. with BA, so as to keep the reactive and power components in the motor equal. Draw OD at an angle of 26 deg. (corresponding to 90 per cent p.f.) with OA, until it intersects the line BC. Then the value of the different lines may be tabulated as follows:

OA is the present kw. load.

OF is the load after the addition of the motor.

OF ÷ OC is the new power factor.

BC is the motor rating.

BE and EC are the reactive and power components of the motor.

EC ÷ BC is the motor power factor.

These problems illustrated by the foregoing examples are all of the type in which the corrective effect of added load has been the governing feature. It is, however, common practice to replace present motors of low power factor with motors of unity power factor, leaving the total power load the same. In the next article we shall discuss this aspect of power factor correction and present a number of examples.

Electricity---What It Is and How It Acts

PART III. CONSIDERATIONS REGARDING THE ARRANGEMENT OF ELECTRONS IN THE ATOM, WITH SPECIAL REFERENCE TO THE BOHR THEORY

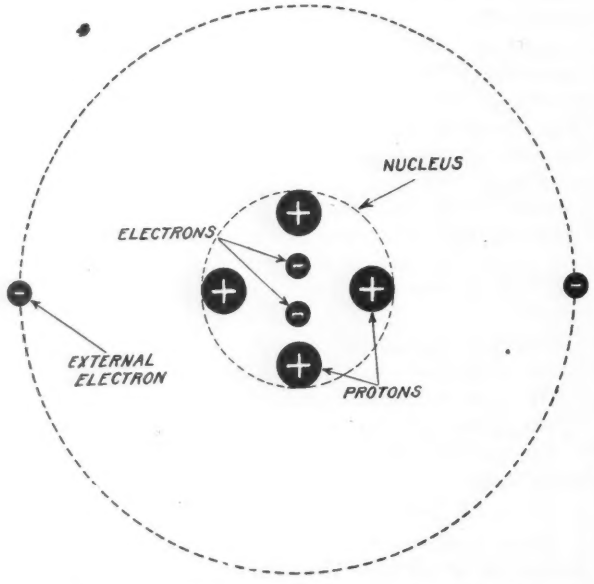
TO THOSE WHO HAVE been following this series of articles in anticipation of learning something about electricity, it may seem that we are unduly slow in getting started and that we have been sidetracked onto a discussion of the atom. This is necessary, however. The atom plays a vital part in most ordinary electrical phenomena and a knowledge of the former is essential towards an understanding of the latter.

An atom, we have learned, is a complex structure resembling a miniature solar system, consisting of a central positively charged nucleus, with one or more electrons grouped around it, the total negative charge of all the electrons being just sufficient exactly to neutralize the excess positive charge of the nucleus. An electrically charged body is one in which a number of atoms have lost or gained electrons below or above the number required to satisfy the normal (uncharged) system. The amount of electric charge carried by a body depends entirely upon the number[1] of atoms in that body so affected. If but few of the atoms of a body have had an electron removed (or added) the body has a small charge; if a large proportion of the total number of atoms in the body have had an electron removed (or added) the body is highly charged.

[1]Always a small proportion of the total number of atoms constituting the body.

Considerations Underlying Concepts of the Atom

In discussing the structure of the atom, it is necessary to preserve a logical attitude of mind, for after all, in trying to form a mental picture of the atom we are engaging in a process in which reason plays an important part. We must consider the fact that all we know about the atom is learned not by actual observation but by certain logical deductions based upon the physical, chemical and electrical effects of the atom under certain conditions. As a matter of fact, we can not say definitely that we know just how the component elements of the atom are arranged but it is logical to suppose (and there is much experimental evidence for this view) that electrons revolve around the positive center or nucleus in much the same way as the earth and planets



CONVENTIONAL MODEL OF THE NEUTRAL HELIUM ATOM

Note: In accepting the Bohr conception of the atom, it is necessary to differentiate between two kinds of electrons: first, those which revolve externally with respect to the central nucleus and in orbits comparable with the diameter of the atom itself, and a second group which are intimately associated with the nucleus.

revolve around the sun. For positive and negative charges attract and it is only by assuming the electrons to possess a centrifugal force due to rotation that it is possible to explain how they can maintain themselves in apposition to the attraction of the nucleus. This conception of the atom, together with certain mathematical deductions supporting experimental evidence, was first proposed by Professor Niels Bohr and this conception is usually referred to as the Bohr atom.

Of a number of theories advanced, the Bohr theory has been the most satisfactory in accounting for radiation and electrical phenomena. True, other theories have been proposed which have their merits so the question of just how the atom is constructed is not entirely settled. It is well, therefore, in accepting the Bohr atom, to do so with an open mind. All through the ages, it has been man's failing to interpret unknown phenomena in terms of that with which he was already familiar. This is but natural but in the scientist it should be constantly guarded against, for it often leads to erroneous conclusions. It is, of course, illogical to suppose that a law which holds true in a certain range of space and time will not hold true in a different range of space and time, for that would be accusing Nature of an inconsistency that she does not deserve.

At the same time, it is logical to suppose that a law which gives certain results in one space and time will give entirely different results in another space and time, because of certain unknown modifying influences. The trouble is not with nature's laws but with our ignorance of modifying influences. There is no inconsistency in Nature.

Scientific knowledge accumulates gradually by a combination process of reasoning and experimental research. A certain theory or conception may serve its purpose for years, when suddenly new experimental evidence upsets it completely but this does not necessarily imply that the original hypothesis was entirely false, or in the exceptional case that it was false, that it had not served some useful purpose. The spurious theory may have furnished the idea for the experiment which finally resulted in its overthrow. In scientific research the scientist and the philosopher are interdependent.

So in presenting the Bohr atom, while we caution the reader against a too rigid belief in the actual arrangement it supposes, at the same time we cannot overemphasize its importance in furnishing us with the vast amount of practical scientific knowledge forming the basis of modern physics. For the Bohr theory reveals the finer and more subtle details of the structure of the atom and serves to unify and explain a vast amount of unrelated physical, chemical and electrical phenomena.

In accepting the Bohr view of the atom, it is necessary first to differentiate between the two groups of electrons within the atom, first those which revolve externally with respect to the central nucleus and in orbits comparable with the diameter of the atom itself, and a second group, which are intimately associated with the nucleus and which, if they revolve at all, do so in orbits closely associated with the positive charge. Thus we have the atom shown in Fig. 2 of the preceding article, which is repeated here.

In our explanation of the nature of an electric charge, we have seen that the removal (or addition) of an external electron from an atom does not fundamentally alter the nature of that atom. An atom of copper with an external electron removed is still an atom of copper. The fact that rubbing sealing wax with flannel removes electrons from the atoms in the wax does not necessarily alter the wax. It is still wax. So we know that it is not merely the number of external electrons that differentiate one atom from another.

Difference in Various Materials Due to Charge on the Nucleus

The secret of the difference between atoms of different materials, copper, iron, oxygen, etc., therefore, must lie in the nucleus and experiments have clearly proved this. The man who did most towards solving this important problem was a scientist by the name of Moseley. Few people probably have ever heard of Mosely—yet to this brilliant young Oxford graduate, only 27 yr. old when his promising career was cut short at Gallipoli during the war, must go the credit for conducting one

of the most profound and brilliant feats of scientific research of modern times. For when Mosely, in 1912, turned the X-ray on matter—literally and figuratively —and made it disclose the skeleton of the atom just as certainly as it reveals the position of the bones in the human body, we were able for the first time to understand the reason for the difference between gold and iron and lead and other elements.

Space will not permit us to describe Mosely's experiments here, further than to say that by stimulating the electrons in atoms of different substances by X-rays he was able to cause these electrons themselves to emit X-rays whose properties he examined. From these X-ray spectra, he found that the net charges on the nuclei of the atoms were proportional to the numbers which would be obtained by arranging all the atoms (that is, of all the chemical elements) in a row in the order of their atomic weights, and then numbering them according to the position they occupied in the row, starting with hydrogen, the lightest.

In other words, if we call the charge on the nucleus of the hydrogen atom, e, that on the next heavier element, helium, would be 2e, that on the next heavier 3e, and so on. The entire 92 elements can be grouped in this fashion. The number which designates the charge on the nucleus in terms of the charge of the nucleus of the hydrogen atom is called the *atomic number* of that element and the nucleus of the hydrogen atom itself is the proton we have been discussing.[2] In the accompanying

A LIST OF THE ELEVEN LIGHTEST ELEMENTS ARRANGED IN THE ORDER OF THEIR ATOMIC WEIGHTS

Atomic Weight	Element	Symbol	Charge on Nucleus (Atomic No.)
1.008	Hydrogen	H	e
4.	Helium	He	2e
6.94	Lithium	Li	3e
9.1	Beryllium	Be	4e
11.	Boron	B	5e
12.	Carbon	C	6e
14.01	Nitrogen	N	7e
16.	Oxygen	O	8e
19.	Fluorine	Fl	9e
20.2	Neon	Ne	10e
23.	Sodium	Na	11e

table is presented a list of the eleven lightest elements arranged in the order of their atomic weights, and showing the simple relation between the charge on the nucleus and the position they occupy in the column.

Atomic Number and Atomic Weight Must Not Be Confused

These two terms, atomic weight and atomic number, must not be confused. If we add one proton to the nucleus, we increase the atomic number by unity. If, however, we add a proton and an electron together, we do not change the charge on the nucleus at all. Its atomic number is the same as before and the external electrons travelling around it are quite unaware of the change. The weight of the atom will, however, be changed. It is possible, therefore, to have atoms with the same atomic numbers but with different atomic weights. Such atoms are called isotopes. In other words, isotopic elements are those which are not separable, therefore not distinguishable by any known chemical methods but which may be differentiated by differences in their physical properties.

Since the atomic number is a measure of the net charge on the nucleus, it is evident that it is also a measure of the number of external electrons in the neutral atom. In other words, the atomic number tells us at once how many external electrons the neutral atom requires. These external electrons are exceedingly important, for it is in them, in their number and arrangement, that we find the explanation of chemical combination. The external electrons are also responsible for the production of light and X-rays.

Chemical Combination

In chemistry, the ability of one element to combine with another is called valance. Some elements combine readily with others, some not at all. Elements which do not combine with others are said to be inert, examples being helium, argon and neon.

Whether an element combines readily with another depends upon the external grouping of the electrons in the atom. In his exceedingly interesting book, "Within the Atom," John Mills draws an interesting parallel between the arrangement of the nucleus and electrons in atoms and a group of children playing a circle game about a teacher. "Suppose that the game goes best with eight in the ring but is possible with any number between 6 and 10. If 10 are playing, that is, if the teacher's responsibility is for 10, as might be the case for electrons if the nucleus has ten excess protons, then there is some crowding. An opportunity for two children to join an adjacent but less crowded circle will be welcomed by the children, and by the teacher also, if she can satisfy her quantitative obligations by supervising their play in a neighboring circle."

In the same way, an atom with a circle crowded by electrons is in an unsatisfied condition which is favorable to losing electrons. If it does so, it will have more protons than electrons and an atom with this tendency towards an excess of protons is said to be electropositive. Such an atom can supply atoms to any other atom which can accommodate them in its circle but if it does so, the two atoms must remain together, for each nucleus has responsibility for a definite number of the total electrons. In this way, a molecule of two atoms is formed. Of course, in order that the second kind of atom may accommodate the excess of the former, it is necessary that it have a complementary need. In other words, it must have fewer electrons than can be satisfactorily accommodated in its ring. Such an atom is said to be electronegative.

On the other hand, if an atomic system has a number of electrons just sufficient to be satisfactorily accommodated in its circle game, it will have no tendency to part with nor acquire electrons belonging to other systems and such atoms are said to be inert. Atoms with more electrons in their rings than can comfortably be accommodated in this circle game are electropositive.

In the next article, we shall discuss briefly the arrangement of the electrons in the various chemical elements in so far as they relate to electrical matter.

[2] W. F. G. Swan, "Journal of the Franklin Institute."

Power, Light and Heat for New Schroeder Hotel

MILWAUKEE'S NEWEST HOTEL COMBINES MECHANICAL AND ELECTRICAL EQUIPMENT FOR CONVENIENCE WITH ARCHITECTURAL BEAUTY OF SURROUNDINGS

FAIR APPRECIATION of the complexity and scope of mechanical equipment at the new Schroeder Hotel, Milwaukee, Wisc., may be had when it is realized that the gas service is greater than that of the City of West Allis and that the water service main entering the building is of the same diameter as is used in Racine, the second largest city in Wisconsin. Over 300 mi. of piping, including electrical conduit, and ten carloads

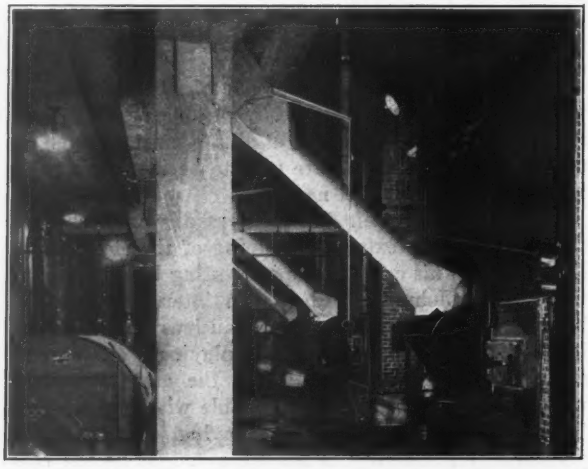


FIG. 1. BOILERS ARE FED FROM OVERHEAD BUNKERS

of plumbing are installed. Altogether there are 115 motors ranging in sizes from ⅛ hp. to 75 hp. The power load is expected to be nearly 1000 hp. and the lighting load will be about 2000 hp.

Because of the low rate at which electricity may be purchased, installation of power equipment was thought to be inadvisable at this time but space has been provided for such installation and feeder lines have been so laid that, if at some future time it shall be found advisable to do so, equipment for furnishing electric power and light may readily be installed.

Not only is the New Schroeder, with its 850 guest rooms, the largest hotel in Wisconsin but it is also the tallest building. Notwithstanding its great height, it has been so proportioned and so embellished that it stands as a monument of beauty. Correspondingly is it complete in its mechanical appointments. Reliability of service for the comfort and physical needs of its guests is, therefore, assured. All units, where possible, are installed in duplicate and provided with different drives; even the supply connection for water has been made to two independent 6-in. mains, one from Wisconsin St., the other from 5th St., feeding into a concrete surge tank.

Steam is now made principally for heating and laundry purposes. Three water-tube boilers of 300 hp. each have been installed in the basement, which is 40 ft. below ground level, and provision has been made for the installation of a fourth unit.

An overhead bin 24 ft. deep, built of concrete and steel, with a capacity of 300 t., is served with coal dumped directly from trucks at grade. This fuel is fed through gates and chutes directly into the stoker hoppers, the flow of coal being regulated by means of a check which is operated by hand from the firing floor. Red Jacket screenings, a West Virginia anthracite, are used as fuel. Steam jets are used to remove the ash and discharge it into an overhead ash bunker, a continuous bucket type conveyor being installed for emergency use. The ash bunker is supplied with a 24 by 24-in. double undercut cast-iron coal gate to which a steel hinged ash chute, approximately 6 ft. long and supplied with cable pulley and counterweight, is attached.

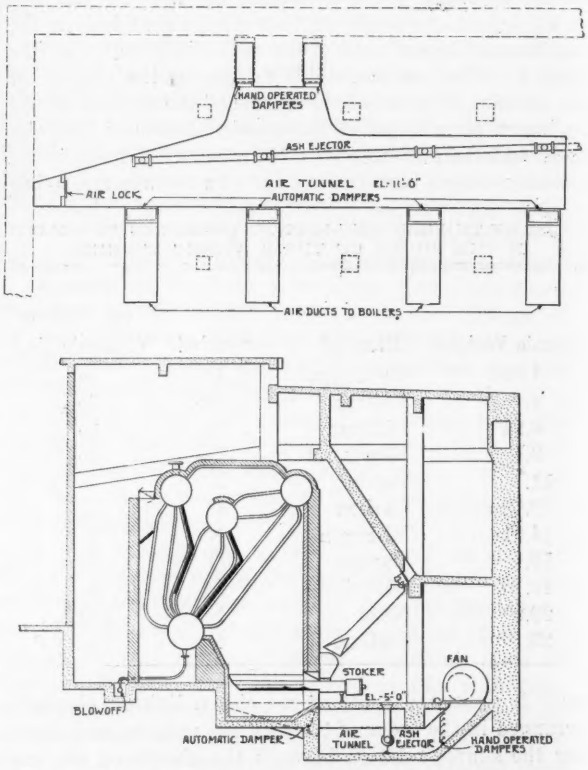


FIG. 2. CROSS SECTION OF BOILER SETTING AND METHOD OF AIR CONTROL

Forced draft is supplied by duplicate fans, one of which is motor-driven, the other driven by a steam turbine. The forced draft fans, dampers and stokers are all regulated by a master regulator. The stack, which is 6 ft. 10 in. in diameter and 285 ft. high, is of steel with welded joints.

From the steam drums at the boilers the steam passes to a 10-in. high-pressure header which is cross connected to an auxiliary steam header so as to permit repairing the main header without interfering with continuous operation of the plant. From the auxiliary steam

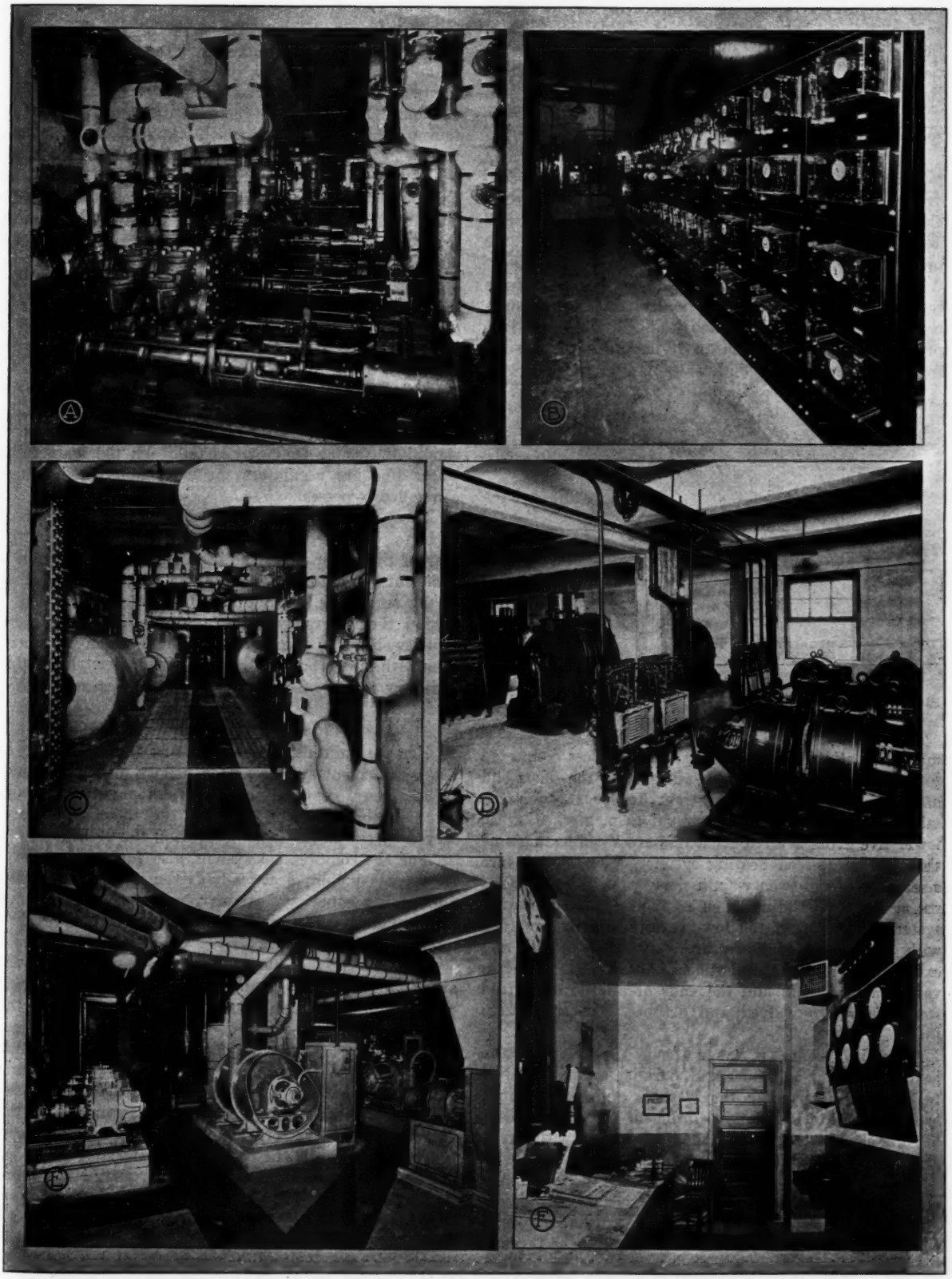


FIG. 3. VIEWS OF SCHROEDER HOTEL SERVICE EQUIPMENT

A—Pump room containing boiler feed pumps and service pumps. B—Switchboard from which all circuits are controlled. C—Water heaters in basement serve both water systems. D—Elevator machinery in pent house. E—Vacuum cleaning and refrigerating machinery. F—Engineer's office contains complete equipment for obtaining performance records.

header, steam is taken to such accessories as stoker engines, steam ash ejector and turbine-driven units. Both main steam header and auxiliary steam header are tied into a high-pressure manifold from which point steam is taken for various purposes. At the other end of the main header is also a connection into the house system.

From the manifold, a 4-in. high-pressure line is taken to operate the two boiler feed, two vacuum and steam-driven house pumps; also, a line to a high-pressure header, from which the various kitchen, laundry and house-heating systems receive their steam through the several reducing valves.

For the house-heating and other low-pressure steam requirements there are four tandem sets of pressure-reducing valves, two of which lead into an 18-in. low-pressure manifold, whence an 18-in. line passes to the five hot-water heaters and a 14-in. line to the 14-in.

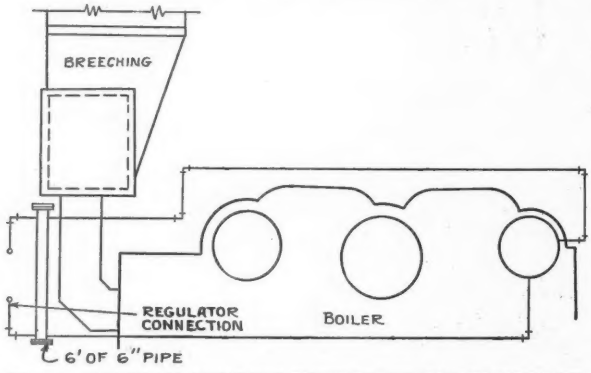


FIG. 4. DIAGRAM SHOWING METHOD OF CONNECTING UP FEEDWATER REGULATOR

up-feed heating riser. This last line is cross connected to the steam supply which is taken from the other end of the main high-pressure steam header through the other pair of tandem reducing valves mentioned. The lower five floors are fed from this cross connecting line through an up-feed heating system. The low-pressure riser goes to the twenty-sixth floor where it distributes steam for the building, then to the down-feed heating system. The top of the low-pressure riser is provided with a cast-iron back-pressure valve with bypass and exhaust head to the atmosphere. Each steam riser is valved at the main and the ends of all the down-feed steam risers are valved and dripped into the return lines.

Laundry steam is taken from the high-pressure header where it is reduced in parallel reducing valves to 25 lb. for servicing the washers and similar open machines and to 100 lb. for equipment containing closed heating elements. Every washer is equipped with a trap and bypass.

Steam for the coffee shop and fifth floor banquet kitchen and bake and pastry shops is taken from the high-pressure header, reduced in pressure to approximately 40 lb. and distributed to the equipment through individual pressure-reducing valves on equipment such as steamers that require a pressure lower than 40 lb. Each piece of kitchen equipment is equipped with a trap and bypass. In both laundry and kitchen, every piece of equipment has a globe control valve and a gate valve above so that the repairing of one item will not interfere with the operation of the rest.

All low-pressure returns are brought to a vacuum pump header, from which there is connection to each of the two vacuum pumps and a bypass to the sewer. The vacuum pumps discharge the water to a return receiving tank on the second floor, which has a float control son water makeup. From this tank the water is fed by gravity to the feedwater heater. All the high-pressure drips are discharged directly into the feedwater heater and arrangement is made for the steam pump exhaust to go into the feedwater heater. Both feedwater heater and return tank may be bypassed should one or the other require shutting down. From the feedwater heater the water is fed by gravity to the boiler feed pumps which discharge into main and emergency feedwater lines. Soft water connection is made directly to the boiler feed pump suction lines. The connection to both main and emergency feedwater lines is made to the high level hot and cold water systems of the building, which provide either hot or cold feedwater makeup should the boiler feed pumps fail. On the main feedwater line are regulators for each boiler with hand-controlled bypasses.

Because of the cramped conditions it was necessary to install the feedwater regulators on the wall in the rear of the boilers. As the breeching did not permit a sufficient pitch to be given to the steam lines leading to the regulators, an auxiliary boiler drum was placed behind the boilers by using a six-foot length of 6-in. pipe, as shown in Fig. 4, the middle of which was about even with the normal water line of the boiler. From this auxiliary header, the regulator connections were made.

Water Is Supplied for Many Services

For the building, water supply is divided into three levels; basement and first floor, at city pressure, second to 9th floors, supplied through a compression tank located in the basement, and the 10th floor and above, served by two house tanks located on the 28th floor.

For the compression system, also for the high-level system, 500-g.p.m., electrically-driven centrifugal pumps and similar capacity steam-driven reciprocating pumps are provided, automatically controlled by the pressures established in the tanks.

Due to the fact that the city pressure usually is about 55 lb., a cross connection is made from the city mains to the compression system, which eliminates the use of those pumps much of the time.

Hot water is provided for the compression system by taking water from the compression tank and passing it through a hot water heater. It is then fed up to the 9th floor in various pipe shafts and returned to the basement hot-water return header by separate lines in the pipe shaft. At the 9th floor ceiling, a vent header is installed which connects to each hot water riser. From this, two risers are run to the 25th floor and left open over slop sinks.

To obtain hot water for the high level system, the line is brought from the house tanks on the 28th floor to the two heaters located in the basement and, after heating, the water is again brought up to a hot-water distributing main in the 25th floor ceiling where it distributes water to the various pipe shafts. The hot-water

risers in the pipe shafts are carried to the basement where they are connected to a header and returned to the heater.

City water for drinking is passed through two sand filters, ozonized and pumped to a fill tank on the 28th floor, whence a line is connected to the return drinking water header located on the 25th floor ceiling, to keep the system full and free from air binding. Circulation is through a return line from the 25th floor to the basement drinking water cooler, then by circulating pumps to the distribution header on the basement ceiling and pipe shafts to the return main on the 25th floor ceiling.

is equipped with an air cooler capable of reducing the outside air temperature 25 deg. A recirculating duct from the dining room is connected to the dining room supply duct between the air washer and fan.

In the basement, the exhaust system provides a large plenum chamber into which all fans exhaust, with self-closing dampers for each branch. From this plenum chamber, sheet metal ducts convey the exhauster air to the pump, heater and boiler rooms through louvred, hand-controlled openings, an exhaust air masonry shaft connected with the plenum system conveying the surplus exhaust air to a point above the alley, which is about

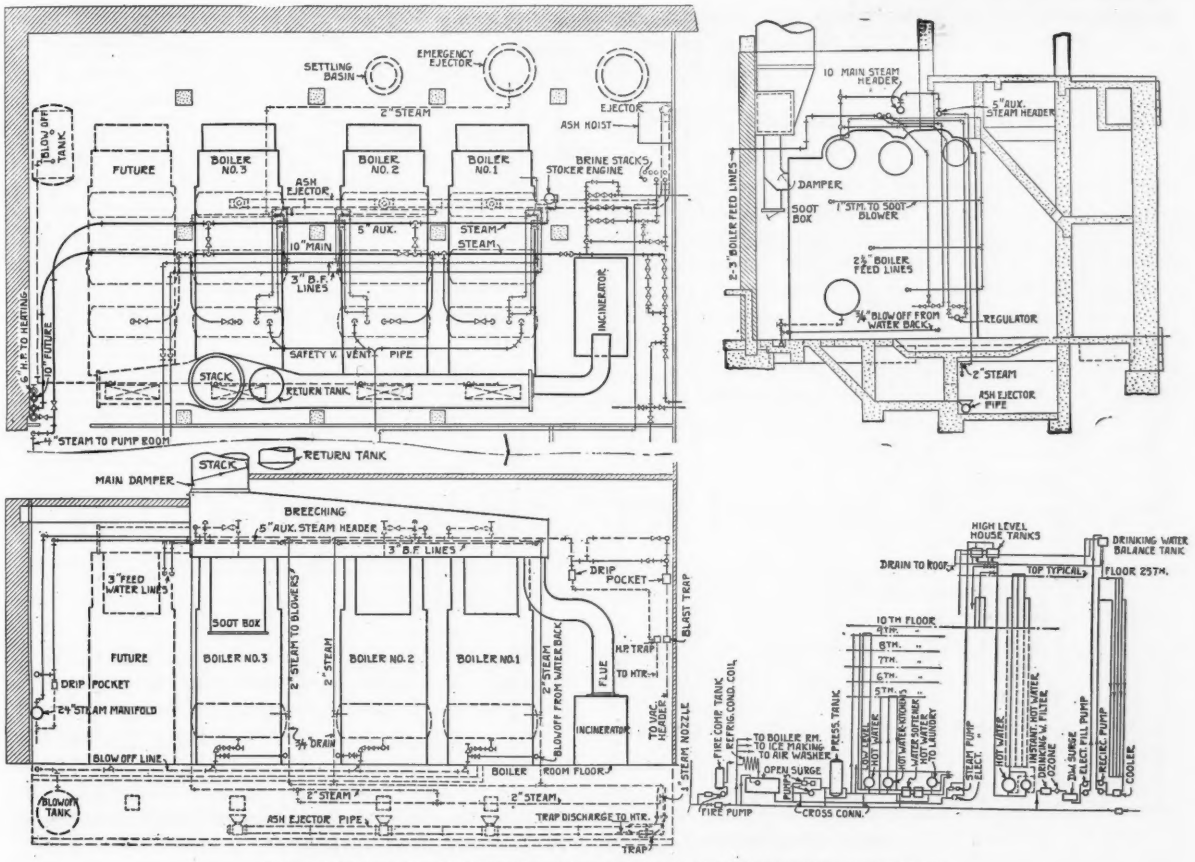


FIG. 5. BOILER ROOM PIPING SUPPLIES MANY DIFFERENT SERVICES

Ventilation is divided into two main parts: the second floor and below is serviced by fans in the basement; the third and upper floors including kitchens are serviced by fans located on the fourth, fifth, seventh and attic floors, the only exception being that all kitchen range exhaust goes to fans in the attic, a total of 27 fans being used.

Supply for the basement fans is taken from above the west alley through a masonry shaft where it is heated by preheating vento coils to a temperature of approximately 50 deg., then passes through a self-cleaning air filter and is directed into a tunnel below the basement floor to the various supply fans. Each supply fan is equipped with reheating coils operated by a pilotstat located in the room serviced by the particular fan. Similar arrangement is made for the fourth floor fans.

Supply for the main dining room and coffee shop

200 ft. away from the supply point. Toilet exhaust for basement, 1st and 2nd floors is brought to a fan in the basement and discharged directly to an exhaust louvre in the alley. The toilets in the guest rooms are ventilated through the masonry pipe shafts which are connected on the 25th floor to each other and carried to the two fans located on the 26th floor, where the air is discharged to the atmosphere.

Air conditioning is accomplished automatically, the air being cooled by refrigeration or heated by steam under thermostatic control so that clean air may be supplied by the ventilating system at any temperature desired.

Carbon dioxide refrigerating machines are used because of their small size and to avoid danger from leakage of the refrigerant. Two machines are installed to run, one at 180, the other at 150 r.p.m., the former to

handle the winter load while both are required during the hottest weather.

For raw water ice making and air cooling, a direct-expansion system is used because of its greater efficiency in heat transmission. The brine circulation system is employed for all other refrigeration because it is more convenient and there is less danger and loss from leakage.

Brine is cooled to two different temperatures; a 10-t. capacity, zero-degree brine cooler serves all ice cream departments and the banquet kitchens, a 35-t. capacity, 15-deg. brine cooler handling all other refrigeration and kitchen loads, ice storage room and drinking water cooling. For air cooling, a coil of submerged type, having a capacity sufficient to supply refrigeration for cooling 15,000 cu. ft. of air to 25 deg. F. is supplied. The brine piping is covered with pitch-coated cork covering of standard thickness for the 15-deg. and double thickness for the zero-degree systems. Drinking water is cooled in a cylindrical tank which is fitted with brine coils capable of delivering 15 t. of refrigeration to the drinking water, so that it leaves the tank at 40 deg. F. This cooler is covered with 2 in. thick wire-reinforced molded cork sheet, painted with pitch, finished with waterproof cement and covered with canvas. All tanks and coils are hot galvanized.

Six electric passenger elevators, with safety governors, operating at 600 ft. a minute, and three service elevators, operating at 500 ft. a minute, are provided. One hydraulic elevator operates between the basement and second floor in the rear of the building for engine and store room supply service. Floor leveling is accomplished by automatic limit switches provided at each hatchway and operated by the car as it approaches the floor so that the car is slowed down and brought to a complete stop, independently of the operator of the car.

Switchovers Reduce Work When Changes Are Made

All electric service is direct current, supplied by the Milwaukee Electric Railway and Light Co., at 110-220 v. for lighting and 220 v. for power, the switchboard room being located in the basement. The switchboard for the laundry has automatic features, so that, for example, if you close the door on a washer, the washer automatically starts to rotate. Switchovers are provided in the rear of the switchboard so as to avoid the necessity of changing electric meters in the stores when occupants of these stores move out. Remote control, operated by floats in the tanks in the pent-house is employed for motors on the house pump in the basement, on high and low level systems, sump pumps, alarm meters and on the water softening system.

High voltage is required for the neon tubes used in the electric signs on the roof of the building. In order to attain this high voltage without danger, the unique arrangement indicated in Fig. 8, by which current at 110 v. is conveyed from the main switchboard room to the roof where it is transformed to 14,000 v., was evolved.

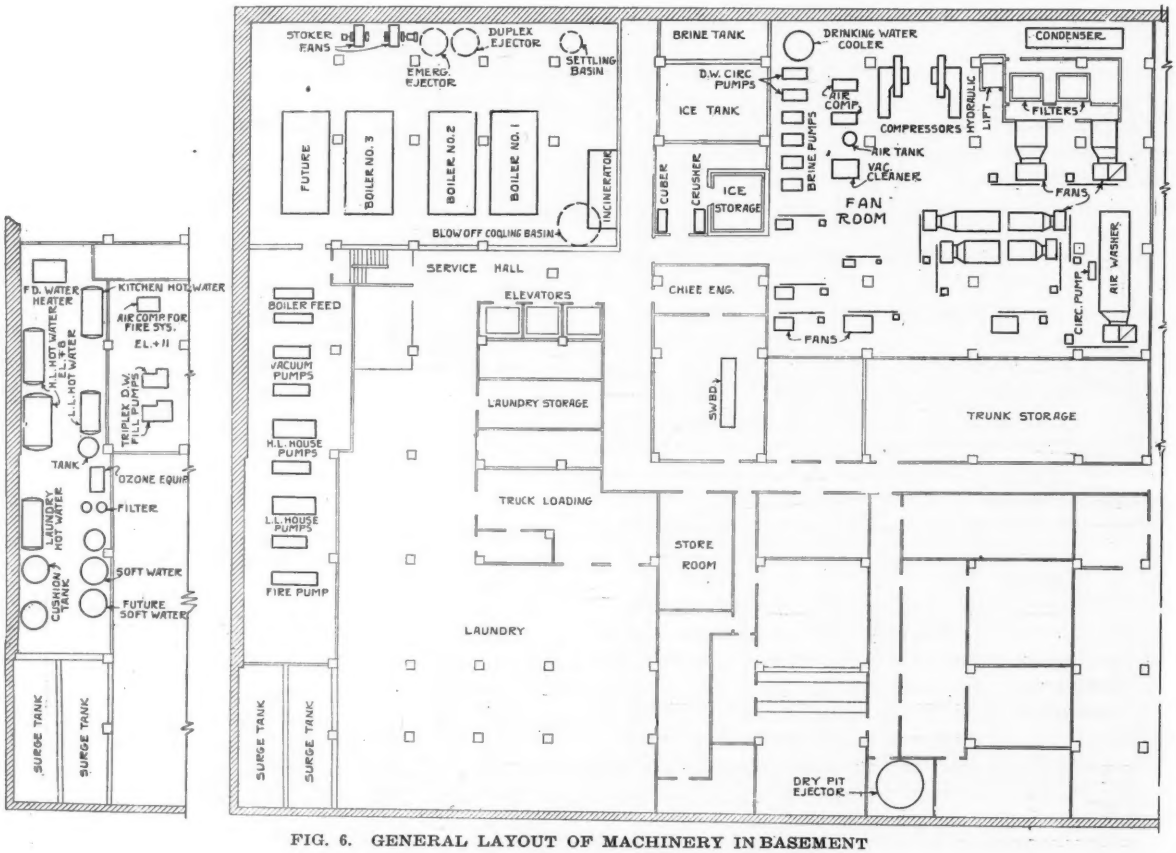


FIG. 6. GENERAL LAYOUT OF MACHINERY IN BASEMENT

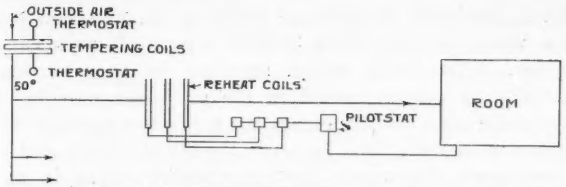


FIG. 7. DIAGRAM SHOWING THERMOSTATIC CONTROL

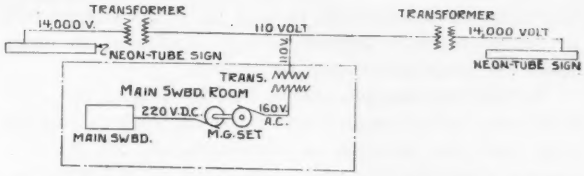


FIG. 8. SCHEME OF HIGH-VOLTAGE CURRENT SERVICE TO ELECTRIC DISPLAY SIGNS

Vibration caused by machinery has been effectively avoided by setting all machinery on 3-in. oak planks which rest upon 1½-in. thick cork, under which is another layer of 3-in. planks laid on the concrete foundation. This concrete foundation is kept separate from the building foundation by an open space at the sides and a 1½-in. thick cork layer below, the concrete portion extending 30 in. below the floor level.

Laundry and all soil piping in the basement are served by duplex-dry-pit type ejector pumps, which are of the non-clogging type, each having a capacity of 400 g.p.m. under a discharge head of 30 ft. These pumps, which are driven by 10-hp., vertical, slow-speed motors, have removable plates for cleaning and repair purposes and discharge to a cast-iron receiver 5 ft. in diameter with dished bottom to prevent accumulation of solids.

Various services are supplied by two air compressors, each of which has a capacity of 50 cu. ft. of free air per min. at 100 lb. pressure and at 80 deg. F. The compressed air storage tank, which is 36 in. in diameter and 8 ft. high is suitable for 100 lb. working pressure. Mufflers are installed with the unloaders in order to reduce noise. Air service is provided for blowing out motors and equipment, with hose connections in all parts of the plant.

Complete Recording Devices Lead to Efficient Management

In the chief engineer's office is a master gage board with high and low level gages, indicating and recording gages. A Telautograph system, which connects all heads of departments, has been installed, thus effecting control and co-ordination of the many services, which are necessarily located in widely separated parts of the hotel. The building and plant were designed by Holabird & Root, architects and engineers, of Chicago. Installation was made under the supervision of Otto J. Bublitz, chief engineer of the nine Schroeder hotels.

Plant Design Reaches New Peak at State Line

Turbine of 208,000-Kw. Capacity, Built in Three Elements, Using Eight Condensers, Will Be Served by Six Boilers Fired by Unit Pulverizers

SINCE THE ANNOUNCEMENT of the 208,000-kw. turbine for the State Line Station of the State Line Generating Co., progress of the plant and equipment has been a matter of interest in engineering circles. The station is located on the shore of Lake Michigan north of Hammond, Ind., immediately east of the Illinois-Indiana state line and adjoining the eastern limits of the City of Chicago. Most of the land on which the station is to be built has been created by hydraulic dredging methods.

This site will permit the installation of five 208,000-kw. units or a total ultimate station capacity in excess of 1,000,000 kw. Part of the output will be transmitted to the neighboring cities of Hammond and East Chicago at 33,000 v., part to Chicago by 66,000-v. underground cables and part to the outlying territory by 133,000-v. overhead lines. According to present plans discussed before the A. I. E. E., approximately half the output of the first unit will be sent into the City of Chicago and the remainder to northern Illinois and Indiana outside of Chicago. The station, a link in the Insull system serving Chicago and the surrounding territory,

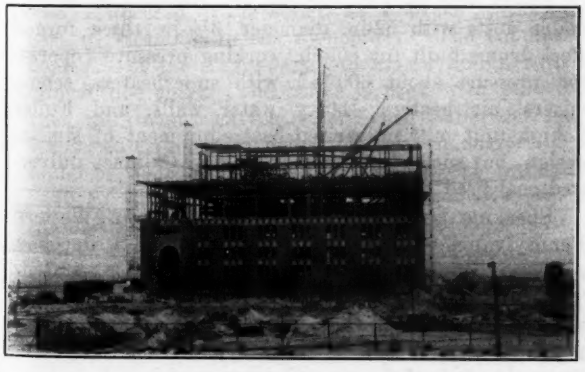


FIG. 1. STATE LINE STATION UNDER CONSTRUCTION, AS IT APPEARED THE LATTER PART OF MAY

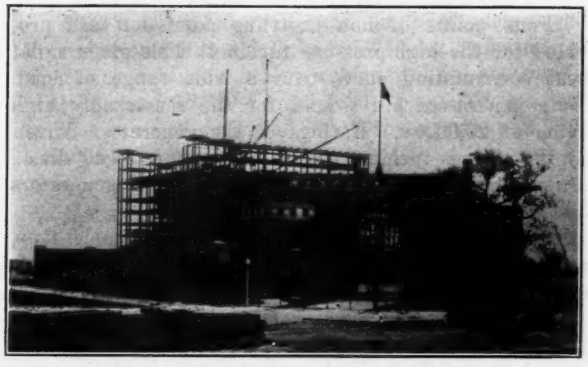


FIG. 2. THIS PICTURESQUE GATE HOUSE LENDS CHARM TO THE OTHERWISE DRAB LANDSCAPE

is unique in this district, in that all of its energy will be transformed to higher voltages and sent to other zones for distribution and utilization.

In the first section, shown in Fig. 1 with the steel work practically complete and the brick work well under way, will be installed a three-element, 208,000-kw., General Electric Co. unit, consisting of a 76,000-kw. high-pressure element with two identical 62,000-kw. low-pressure elements arranged as indicated in the plan, Fig. 3. All elements will operate at 1800 r.p.m., and each of the two low-pressure turbines will also drive a 4000-kw. direct-connected auxiliary generator. The

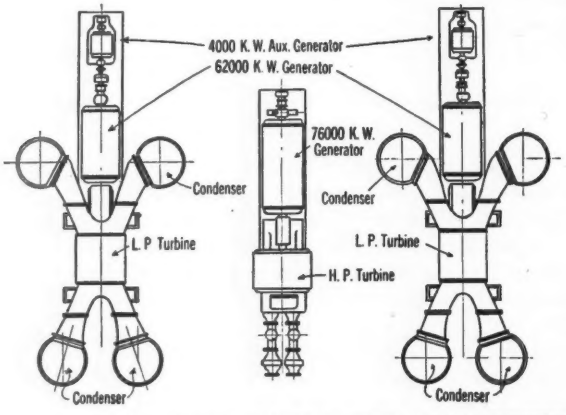


FIG. 3. PLAN VIEW SHOWING THE ARRANGEMENT OF THE THREE ELEMENTS AND DIRECT-CONNECTED AUXILIARY GENERATORS

arrangement of the main generator is such that the three elements will be the operating equivalent of two units.

Cross sections of the high and low-pressure turbines, shown in Fig. 4, were exhibited by G. W. Warren, of the Turbine Engineering Dept. of the General Electric Co., in a paper on high-pressure turbines presented before the Engineers Society of Western Pennsylvania. The high-pressure element will be supplied with steam at a pressure of 600 lb. gage and a total temperature of 730 deg. F. Between the high and low-pressure elements exhaust steam from the high-pressure turbine will be reheated, at 110 lb. abs. pressure, to 500 deg. F. with live steam from the high-pressure header. For the first time in commercial service, five stages of feedwater heating, ranging from a maximum of 380 lb. absolute to a minimum of 9.4 lb. absolute are to be used.

Four points of non-throttling admission are provided for the high-pressure turbine. This gives a flat heat consumption curve over a wide range of load. Main generators are wound for the remarkably high value of 22,000 v. Ratings of the generators driven by the various turbines are: High-pressure 89,400-kv.a., low-pressure 73,941-kv.a. each and auxiliary generators 5333-kv.a. each.

Each of the low-pressure turbines is double flow, arranged so that each set of low-pressure wheels is served by two Allis-Chalmers surface condensers, making four condensers for each low-pressure turbine, or a total of eight condensers for the unit. These condensers are of the vertical, single pass type with cooling surfaces of 22,000 sq. ft. each, making a total of 176,000 sq. ft. designed to condense 1,600,000 lb. of steam per hr. when supplied with 360,000 g.p.m. of circulating water. Circulating water, supplied by four vertical circulating pumps placed in the cribhouse outside of the generating station, enters the condenser through the lower water box, flows upward through the tubes and is discharged downward through overflow pipes in the condenser shell. This arrangement eliminates external piping usual with the standard arrangement.

Condensate will be collected in hotwells and delivered against 250 lb. gage pressure by six 3-stage condensate pumps rated at 1000 g.p.m. each. Air removal equipment will consist of 2-stage steam jet air pumps, the first stage being attached to the condenser shell, the second stage grouped with the inter and after coolers.

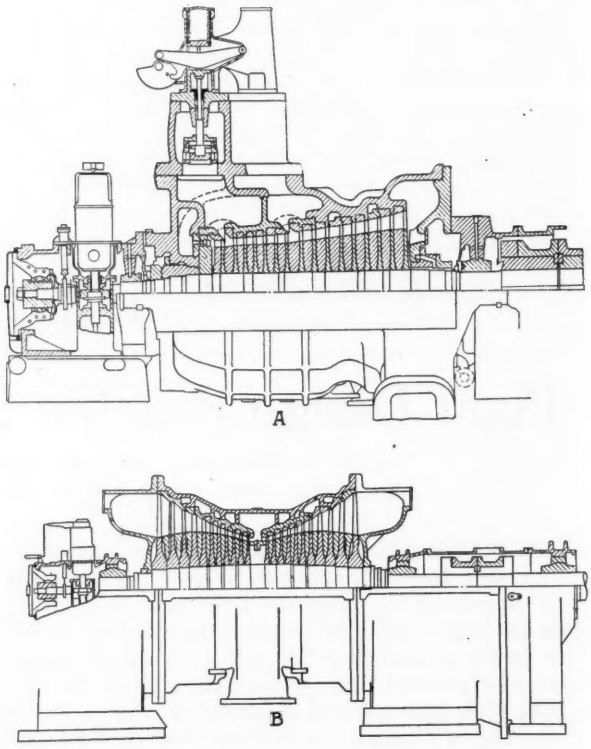


FIG. 4. CROSS SECTION OF (A) THE 76,000-KW. HIGH-PRESSURE TURBINE AND (B) THE 62,000-KW. LOW-PRESSURE ELEMENTS

Steam will be supplied by six Babcock & Wilcox boiler units with 52-in. diameter, 3¼-in. thick forged steel drums built for 800-lb. working pressure (operating pressure about 600-lb.) with superheaters, economizers, air heaters, Bailey water walls, and Fuller Lehigh unit mill pulverized coal equipment of similar design, but somewhat larger, than the Calumet pulverized coal fired boiler unit shown in Fig. 5.

Speaking before the Engineers Society of Western Pennsylvania on high-pressure boilers, D. S. Jacobus, Advisory Engineer of Babcock & Wilcox Co., stated: "The 800-lb. boilers for the State Line Generating Co. are of a larger size than the Calumet boiler and are provided with forged, seamless steel steam and water drums in place of the riveted drum used in the Calumet boiler. The general features of the arrangement, other

than the size of the equipment, conform quite closely to that used at Calumet."

"Figure 5 is a section of this boiler as installed at the Calumet Station of the Commonwealth Edison Co. of Chicago and although built for a working pressure of 375 lb. per sq. in., is described here in view of the fact that its development and performance in actual service led to selecting a similar design for 800 lb. working pressure for the State Line Generating Co. The gases make a single pass over the tubes of the boiler and superheater and then pass through an economizer and air heater. The boiler proper is seven tubes high and built of 3¾-in. tubes 17 ft. long. Steam and water drum is 48 in. inside diameter.

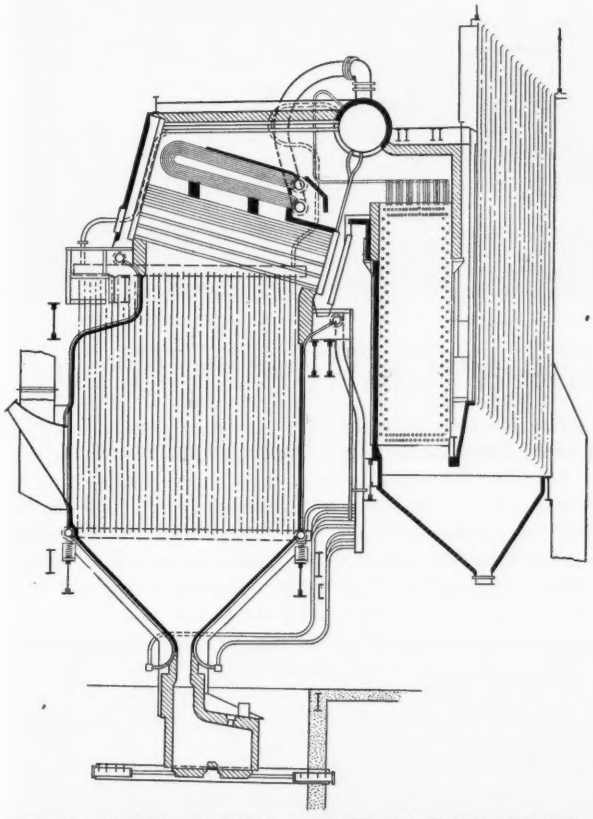


FIG. 5. CROSS SECTION OF THE CALUMET BOILER. GENERAL FEATURES OF THIS ARRANGEMENT, OTHER THAN THE SIZE OF EQUIPMENT, ARE SIMILAR TO THOSE OF THE BOILERS TO BE USED IN STATE LINE

"The economizer is of a loop type, counterflow design, connected to the boilers in a special way to take care of steaming in the economizer. The tubular air heater is of the single-pass counterflow design with inclined tube sheet. The boiler is fired with pulverized fuel, the furnace having water-cooled Bailey refractory walls and Calumet burners. The heating surface of the boiler is 5938 sq. ft., that of the furnace wall tubes 2460 sq. ft. and that of the economizer 8365 sq. ft., making a total water heating surface of 16,763 sq. ft. The surface of the air heater is 41,700 sq. ft.

"Guaranteed output of the unit is 200,000 lb. per hr. and a rate of evaporation as high as 280,000 lb. per hr. has been developed, the limit being governed by the capacity of the draft fans and feed pump. The evaporation in pounds per hour per square foot of surface is given in the accompanying table.

"Only a small portion of the economizer generates steam and the rates of evaporation are closer to the second set of figures than the first. The temperature of the superheated steam when evaporating 250,000 lb. per hr. is 700 deg. F."

Present plans call for the completion of the first unit in 1929 and when completed, State Line Station will be a worthy standard bearer for the Chicago district stations. Since the commercial introduction of the turbine in electric generating service in the early part of the twentieth century, the Insull interests have been foremost in the development of large units and State Line Station bids fair to hold the record for many years. Mechanical design of the station was handled by Sargent & Lundy, Inc., and the architectural design by Graham, Anderson, Probst & White.

EVAPORATION DATA ON THE CALUMET BOILER UNIT

	Total output in pounds		
Evaporation per square foot of heating surface based on surface of	200,000	250,000	300,000
Boiler, furnace and economizer	11.94	14.92	17.90
Boiler and furnace	23.80	29.77	35.71

Cahokia Station to Install 75,000-Kw Turbine

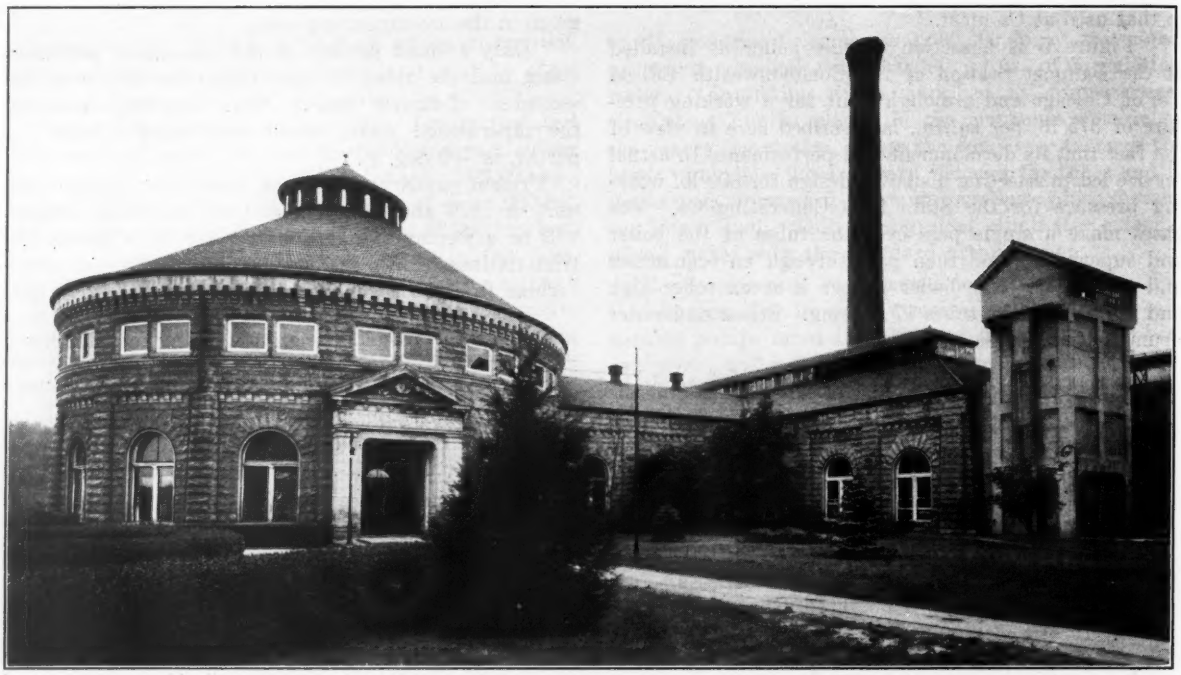
UNION ELECTRIC LIGHT AND POWER CO., of St. Louis, has made plans to remodel and expand the Cahokia station, the largest of its generating plants. The plans include the installation of a General Electric turbine-generator of 75,000 kw. capacity.

Instead of making an addition to the present station building, space for the 75,000-kw. unit will be provided by removing a 30,000-kw. machine. The foundations of this machine will be strengthened to suit the larger unit and the condenser which was used with the 30,000-kw. turbine will be altered and connected to the new 75,000-kw. unit. The unit which is removed will be installed in the Venice station of the company, adjacent to the Cahokia station.

In adapting the old condenser for use with the new turbine, steam will be bled from two stages and will be used to heat the feedwater from this unit as well as that from a 35,000-kw. machine already in the station.

This new turbine will be a single-cylinder machine receiving steam at 315 lb. gage, 300 deg. superheat and operating against a back pressure of 1 in. absolute. It will be rated 75,000 kw. at 1800 r.p.m. The generator will be rated 60 cycles, 13,800 v., three-phase and 90 per cent power factor.

NOTHING in this world is so good as usefulness. It binds your fellow-creatures to you, and you to them; it tends to the improvement of your own character; and it gives you a real importance in society, much beyond what any artificial station can bestow.—Sir Benj. Brodie.



Underground Steam Line at California, Ohio

From River Pumping Station, at California, Ohio, Near Cincinnati, 2570-ft. Line Takes Steam to Filtration Plant and Eliminates Boiler Room in Latter. By W. S. McLeish

BETWEEN RIVER PUMPING station and Filtration Plant at California, Ohio, the City of Cincinnati, Ohio, recently installed 2570 ft. of underground steam line. By means of this line, the boiler room at Filtration Plant has been eliminated and increased efficiency has been obtained, together with great reduction in overhead costs. Steam is obtained from River Pumping Station, shown in the headpiece, located on the north bank of the Ohio River about 10 mi. from Cincinnati. In this station, four huge pumping engines, of 30,000,000 gal. per day capacity each, deliver all the water required by the city to a settling reservoir located near the Filtration Plant.

Boiler equipment at the River Pumping Station has recently been renewed and now consists of four Stirling water-tube boilers, each of 450 hp. capacity, fired by Riley stokers. These boilers easily supply the steam required for the pumps and it was thought that they could also supply the requirements at the Filtration Plant for heating and test purposes. This assumption was more than justified when the steam line was placed in operation, as no apparent shortage of steam occurred nor was excessive stoking required to hold boiler pressure.

Filtration Plant provides an acre of filter surface besides having an extensive laboratory devoted to the purification of the river water. The boiler room at this plant, which is now eliminated, cost approximately $9800 a year to operate, not including depreciation and interest on original investment.

As the City of Cincinnati believed that this expenditure could be avoided by eliminating the boiler room at the Filtration Plant, this proposition was carefully studied by the water works engineers and cost figures were compiled on that basis. Estimates showed that the present operating cost of the boiler room at Filtration Plant would wipe out within 2 or 3 yr. the cost of installing the proposed steam line. Accordingly, in the fall of 1927, the plans and specifications were prepared on this project and the necessary appropriations approved for this work.

Steam Line Was Designed for 150 Lb. Pressure, 120 Deg. Superheat

This system, as installed, consisted of a 4-in. steam line suitable for 150 lb. boiler pressure with 120 deg. F. superheat, no return. The actual working pressure of the line, however, was expected to be only about 80 lb. gage but it was thought advisable to make it capable of holding full boiler pressure in case future requirements may necessitate this pressure. Reduction in pressure was effected by a Boylston reducing valve located at River Pumping Station boiler room. Here a 3-in. valve was used so that it would remain open farther than a 4-in. valve with a similar flow of steam and thus reduce wiredrawing.

To enclose the steam pipe, The Ric-wiL Co. Type F., vitrified split-tile conduit of the Loc-LiP design was used, of 10-in. nominal diameter, insulated with a high-grade, loose asbestos sponge filler, packed firmly around the steam pipe; average thickness of insulation is 2¾ in. Conductivity of this filler was tested by a hot plate

machine to determine its thermal efficiency at the maximum temperature of the steam. The conductivity was found to be 0.42 B.t.u. per deg. difference for one inch thickness at 500 deg. F., outside temperature 70 deg. F.

Base Drain Foundation Supports Conduit

Conduit was supported on a vitrified tile, base drain foundation, which, besides furnishing the necessary trench drain, formed a cradle for the conduit. The sections of base drain interlock and the conduit and pipe supports, spaced 12 ft. apart, wedge solidly between sections of base drain, thus supporting the pipe independent of the tile conduit. Broken stone bed was carried up to the center line of conduit, to prevent any accumulation of water in the soil surrounding conduit. Side joints and bells were thoroughly waterproofed after being cemented. Ric-wiL cast-iron conduit, supported on extra-heavy base drain, was installed under the main tracks of the C. G. & P. Railroad. Figure 1 shows plot plan and construction details, also location of fittings. Figure 2 shows the various stages of construction.

Standard weight National steel pipe was used in 40-ft. lengths so that joints would be reduced to a minimum. This pipe, installed by The Northeastern Piping & Construction Corp., was thoroughly coated with Nitros asphalt paint before being installed on roller supports furnished with the conduit materials. The joints connecting the pipe lengths were acetylene welded, with companion flanges for expansion joints. After welding complete sections of pipe approximately 350 ft. long between manholes, blind flanges were attached to the ends and the complete section tested hydraulically at 300 lb. pressure to insure tight welds. Suitable fiber gaskets were used for flange joints to withstand the high temperature of the superheated steam. Provision for the expansion of the pipe was made by installing 15 single expansion joints about 175

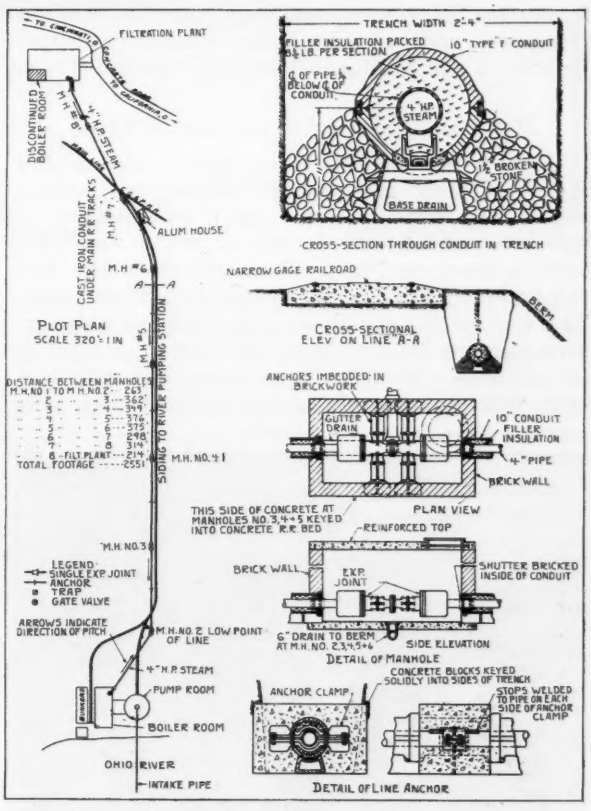


FIG. 1. PLAN AND DETAILS OF STEAM LINE BETWEEN RIVER PUMPING STATION AND FILTRATION PLANT

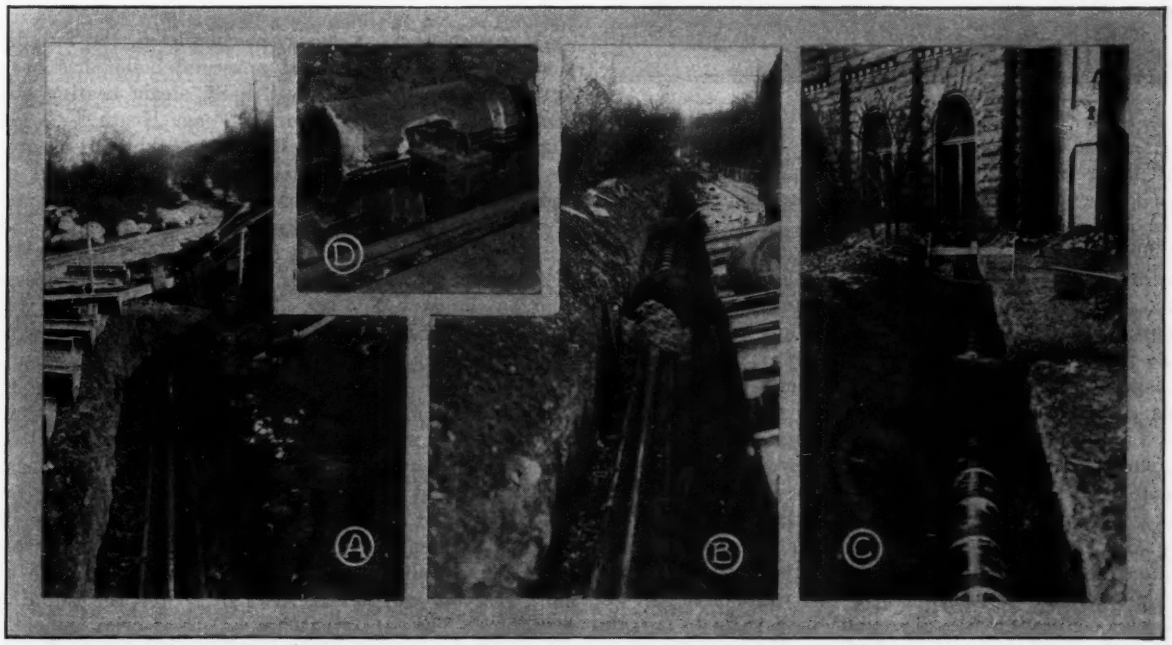


FIG. 2. VARIOUS PHASES OF THE STEAM LINE CONSTRUCTION. A—STEAM PIPE IN CONDUIT. B—PACKING THE FILLER INSULATION. C—LINE WITH WATERPROOF JOINTS COMPLETED, READY FOR BACKFILL. D—ONE OF THE ANCHOR CLAMPS

ft. apart. These were American District Steam Co. extra-heavy, cast-iron joints of the duplex-sleeve, guided type with air cooled slip, each having a traverse of 8 in.

Manholes Accommodate Expansion Joints

Eight roomy manholes were built to accommodate expansion joints, large enough to allow the external guides being slipped over the pipe if it is necessary to repack the stuffing-box. Interior of one of these manholes is shown in Fig. 3. Some manholes were provided with "bay windows" to take care of the guides. This construction can be used to advantage where excavation must be kept to a minimum on account of paving costs. Manholes were constructed with 9-in. brick walls and concrete top and bottom. Steel rails,

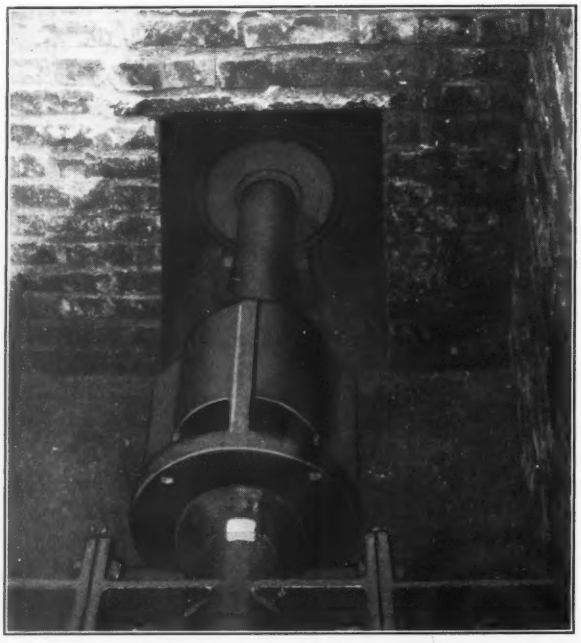


FIG. 3. INTERIOR OF ONE OF THE MANHOLES

used to reinforce the tops, were placed so that the manhole cover would be supported. The anchor wings of the expansion joints were imbedded in brick walls to hold the bodies stationary and allow the moving elements to slip easily and freely. Anchors between manholes were cast-iron, line anchor clamps, secured with eight ¾-in. bolts; in addition, steel stops were welded to the pipe on each side of the anchor clamps to assure positive anchorage. Conduit was cut out for these clamps, as shown on Fig. 1, and the extending portion of the wings imbedded in a solid concrete block 2 ft. square by 3 ft. wide. The steam line was laid approximately 4 to 5 ft. underground, which was deemed sufficient for the grades and efficiencies desired.

High-pressure steam traps placed at low points of the line collect the condensate. The manholes were drained to prevent accumulation of seepage water and surface floods; connection was also made to a suitable outside drain from the low points of the base drain. Pressure recording gages were attached to both ends of the line so that accurate records would be obtained of the fluctuations in pressure, also of pressure drop in the line. Indicating gages were placed alongside recording instruments to check their accuracy. A temperature recording instrument was also attached to the inlet end of the line so that the amount of superheat present in the steam could be determined. Thermometer wells at each end of the line permit drop in temperature to be observed, giving an approximate indication of the efficiency of the system.

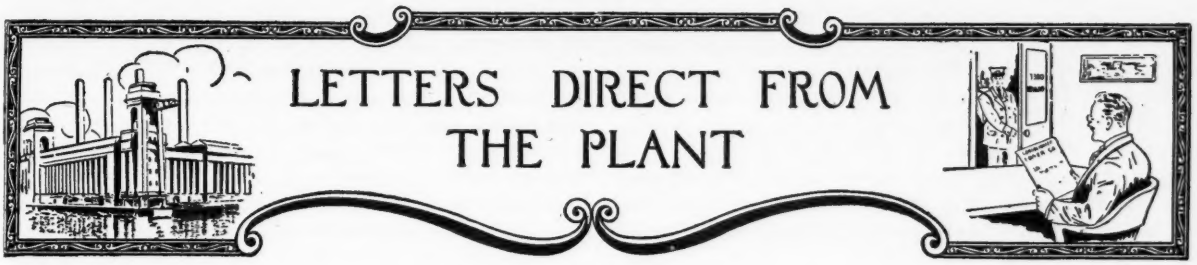
Cost of Installing Steam Line

Cost records of the job, applying only to the underground line 2570 ft. long, are given below. Figure 1 shows line 2550 ft. long; its actual length installed was 2570 ft.

Trench and backfilling	$3775 or	$1.47 per ft.
Conduit materials installed, total	4295 or	1.67 per ft.
Insulation in conduit and manholes installed	2048 or	0.79 per ft.
Broken stone, cement, sand, waterproof paint and tools	285 or	0.12 per ft.
Piping, valves, exp. joints; installed	6021 or	2.34 per ft.
Anchor clamps and manhole covers, materials only	625 or	0.25 per ft.
Manhole chambers and anchors installed (concrete and brick work)	1700 or	0.66 per ft.
Total (except piping and fittings inside buildings)	$18,749 or	$7.30 per ft.

This new steam line was installed within the time allowed by the city and has been in continuous operation for 8 mo. The waterworks engineers feel that it has more than justified their expectations regarding efficiency of the line and reduction of overhead costs.

Excavation work has been completed, the foundations are being placed and a second boiler has been authorized for the new Twelfth St. steam heating station of the Allegheny County Steam Heating Co. in Pittsburgh, a subsidiary of Duquesne Light Co., according to H. W. Fuller, vice-president in charge of engineering and construction, Byllesby Engineering and Management Corp. Steel is now being fabricated and the first boiler is scheduled for operation November 15, 1928, while the second boiler is scheduled to be in operation on January 1, 1929. Each of these boilers will have a capacity of 300,000 lb. of steam per hour with a peak capacity of 350,000 lb. per hr. for short periods. A tunnel approximately 3000 ft. in length will contain the mains which connect these boilers with the distribution system now served by the Stanwix Steam Heating Plant. The new station is being erected on the corner of Twelfth and Etna Sts. Provision is being made for office space and a temporary wall will be built to permit of future extension. There will be a water reservoir under practically the entire building and the base of this reservoir will act as the footing for the building structure. The superstructure will be of brick, concrete and steel construction, with windows having steel sash and wire glass. At the side of the building will be located a concrete coal unloading pit and hopper.



Procedure in Starting Up a New Generator

IN THE FEBRUARY 15, 1928 number, page 253, Marin Phillips discusses "Procedure in Starting Up a New Generator."

I would like to comment on this article with particular reference to Fig. 6. Assuming the connections of the synchronoscope, as shown, to be standard, and assuming potential to be derived from generator and bus potential transformers, there is a possibility of an operator getting into serious difficulty. Assuming the connections to have been made to corresponding phases and opposite polarity of the two potential transformers, then, when the incoming machine is in step, the synchronoscope will stand at 6 o'clock and the lamps will burn at full candle power. Also when the incoming machine is 180 deg. out from the bus, lamps will be dark and the synchronoscope will stand at 12 o'clock.

In my opinion, the only safe way to synchronize a new machine to a bus and get an absolute check on the correctness of synchronizing connections is actually to disconnect the generator from its leads at such a point that the generator potential transformers may be energized from the bus.

No doubt Mr. Phillips is fully cognizant of the difficulties which might be experienced but inasmuch as an operator in a small station might not be familiar with the possible difficulties and accept as gospel the statements in Mr. Phillips' article, he could, as you will see, close the switch to a new generator when the machine was 180 deg. out of phase with the bus.

I should think it would be desirable for Mr. Phillips to submit an additional article bringing out these facts.

Boston, Mass. A. H. SWEETNAM.

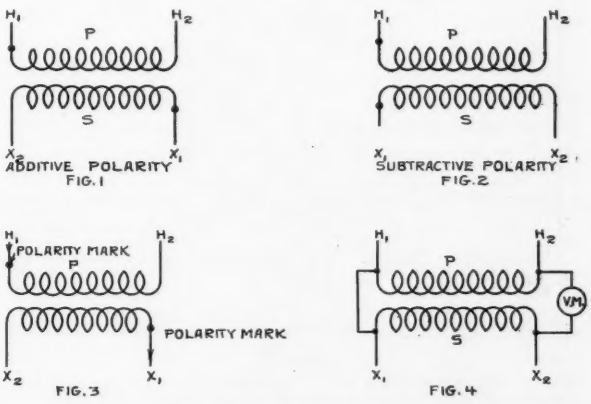
MR. SWEETNAM, in his comment on my article, "Procedure in Starting Up a New Generator" in the February 15 issue, brings out an interesting and important point that I failed to emphasize.

It was not my intention to convey the idea that the synchronoscope was a faultless instrument and that a certain amount of caution was not necessary when making connections.

Each synchronoscope manufacturer furnishes a diagram of connections and an instruction bulletin with his instrument.

It was my idea, when preparing the article, simply to show the connections of a standard synchronoscope and a brief description of how it operated and then let the workman installing the generator follow the manufacturer's instructions regarding the wiring. Mr. Sweetnam brings out the point that the operator in a small plant might not be familiar with the possible difficulties to be encountered and close the switch on a new generator when the machine was 180 deg. out of phase with the bus. This is true if the synchronoscope is not wired correctly and checked properly. No trouble should be encountered if the manufacturer's diagram is carefully followed.

Mr. Sweetnam states, "Assuming the connections to have been made to corresponding phases and opposite



FIGS. 1—4. POLARITY DIAGRAMS OF TRANSFORMERS

polarity of the potential transformers then when the incoming machine is in step the synchronoscope will stand at 6 o'clock and the lamps will burn at full candle power. Also, when the incoming machine is 180 deg. out from the bus, the lamps will be dark and the synchronoscope pointer will stand at 12 o'clock, indicating synchronism." Of course, under these conditions, it will be impossible to parallel the alternator with the bus and an attempt to do so will meet with more or less disastrous results, depending on the size of the system, generator and so on.

When we speak of the polarity of a transformer, we mean the relative direction in which the primary and secondary turns are wound upon the iron core. The polarity is defined either as "additive" or "subtractive" which depends upon the location of the primary and secondary terminals of like polarity.

By referring to Figs. 1 and 2, it will be seen that the primary leads of the transformer are identified by the letter H and the secondary leads by the letter X.

When a new transformer is received for use with switchboard instruments, it will be found that one primary and one secondary lead will be marked usually with white paint. These marks are called polarity marks (Fig. 3).

One primary terminal is painted white and called

H_1 and the secondary terminal of the same polarity is painted white and called X_1. Assuming at any particular instant when the primary current is flowing towards the H_1 mark in the primary it will at this same instant be flowing away from the X_1 mark, in the secondary, let us now assume that an old generator with its switchboard and instruments is to be wired up and put into service and that the instruments have been disconnected and that the polarity markings on the transformers have been obliterated.

To test the polarity of the potential transformers, the connections are made as in Fig. 4. Terminals H_1 and X_1 are connected together and a voltmeter reading is taken across terminals H_2 and X_2 while voltage is applied to the primary terminals H_1 and H_2.

If the voltmeter reads less than 220 v. (that is, assuming that 220 v. is being applied to the primary)

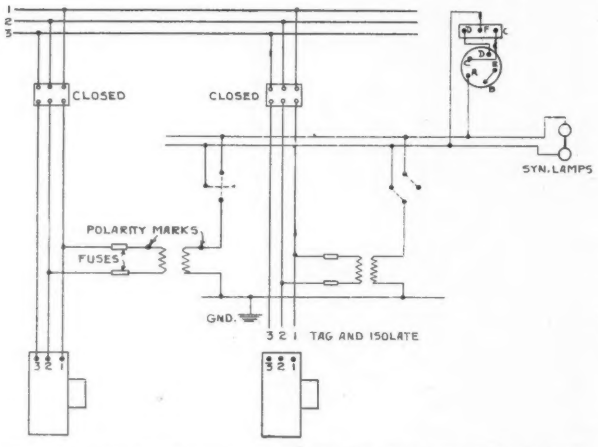


FIG. 5. CONNECTIONS OF A STANDARD SYNCHROSCOPE

the transformer will have a subtractive polarity. If it reads more than 220 v., the transformer will have an additive polarity. Now, how can we properly mark the polarity of our transformer?

The Electric Power Club's rules state that the numbering of transformer leads shall be so applied that when H_1 and X_1 are connected together and voltage applied to the transformer the voltage between the highest numbered H lead and the highest numbered X lead shall be less than the voltage of the full high-voltage winding for a subtractive polarity.

For an additive polarity, the voltage between the highest numbered H lead and the highest numbered X lead will be greater than the voltage applied to the high-tension winding.

Disregarding the markings on the transformer for the high and low-tension leads for the time being, suppose we connect one high-tension and one low-tension lead together, as in Fig. 4, say the leads coming out of the left side of transformer casing when facing the front.

Now, with a test voltage applied to the high-tension leads, read the voltage across the high and low-tension leads on the right-hand side of the casing.

If the voltmeter reads more than the voltage being applied to the high-tension winding, the transformer has an additive polarity.

If the voltmeter test shows the transformer to have a subtractive polarity, the markings on the leads that are connected together will be H_1 for the high-tension lead and X_1 for the low-tension lead. Then, of course, the marking for the other two leads will be H_2 for the high-tension lead and X_2 for the low-tension lead. If, however, the voltmeter test shows the transformer to have an additive polarity, the markings for the leads connected together will be H_1 for the high-tension lead and X_2 for the low-tension lead.

When putting a synchronoscope into service for the first time, its connections should be carefully checked by inserting lamps in the same phase and one other. When this is done, it will often be found that the synchronoscope pointer is displaced 90 or 180 deg. from the synchronizing position while the machines are really in synchronism.

Such a condition is brought about by improper connections or polarity of the potential transformers. In most cases, the synchronoscope bracket will be equipped with a pair of lamp receptacles in the same phase.

This will make it necessary only to connect one set of the lamps into one of the other phases.

The lamps alone do not indicate positively when the machines are in exact phase but they do indicate when the e.m.f. is zero, so that the lamps should become dark when the synchronoscope indicates synchronism.

If they do not, it is certain that something is wrong with the wiring connections. Figure 5 shows the connections of a General Electric synchronoscope and the following instructions on how to test the synchronoscope for proper connections will insure its correct indication of the amount the machines are out of phase.

The first thing to do is to make certain that the pointer is properly set on the shaft. This is checked by connecting points B and E together and to one side of a single phase line of the correct voltage; then connect points A and F together and connect them to the other side of the same single phase line. If the pointer is located in the proper place on the shaft, it will now point vertically upward, to the synchronism mark.

After making sure that the pointer is properly set on the shaft, carefully mark the generator leads at the terminal board. They should now be disconnected and isolated as shown in Fig. 5.

Next, the synchronizing plugs should be inserted in the receptacles, one in the receptacle for the new machine and one in the receptacle on the bus or running machine; now close the circuit breaker on the new generator.

This will now put the same voltage on the rotor and stator of the indicator as in the above mentioned test and the pointer should come to rest in a vertically upward position, indicating synchronism.

If it should point vertically downward, the potential transformer secondary leads to the receptacle of the new generator will have to be reversed. Should it come to rest at a position 120 deg. away from the synchronizing position, it will be an indication that the voltage of the new generator is being taken across the opposite phase to that of the bus.

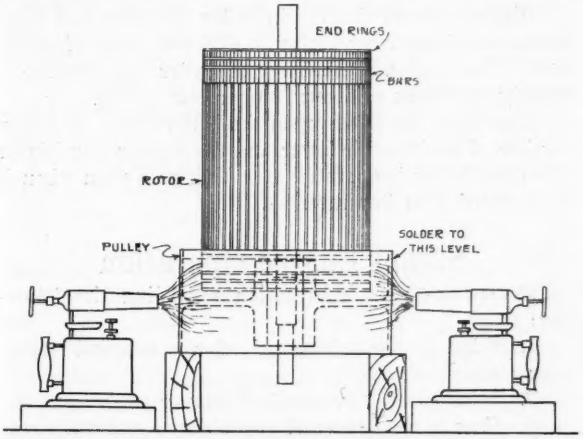
When the connections and synchronoscope have been tested as outlined, open the circuit breaker on the new generator and reconnect its leads onto the terminals and the machine will be ready to synchronize on the bus.

Niagara Falls, N. Y. MARIN PHILLIPS.

Resoldering End Rings of Rotor of Small Motor

SOME TIME AGO, we noted that the speed of our sizing machines was diminishing and upon testing the motor with a tachometer, we found that the speed, instead of being 1740 r.p.m., was only 1400. Connecting a wattmeter in the line, it was found that the motor carried only 2 hp. and, since it was a 3-hp. motor, it was evident that the reduction in speed was not due to overload.

Further investigation showed that the motor was heating and vibrating excessively, which, we decided,



SHOWING HOW BLOW TORCHES WERE USED TO HEAT SOLDER AND HOW ROTOR WAS MOUNTED

was caused by the rubbing of the rotor on the stator due to worn bearing linings.

The motor was sent to the repair shop and when taken apart the end rings of the rotor were found loose on the bars. Removing the rings and bars, we cleaned and tinned the ends of the bars and reassembled the rotor.

Then came the problem of soldering the end rings as gracefully as possible. This we did as shown by the accompanying sketch.

We had an old solid web pulley with a bore large enough for the rotor shaft to pass through. The pulley was laid on blocks high enough for the shaft to pass through and allow the body of the rotor to rest on the hub of the pulley. Solder was poured into the space between the hub and rim of the pulley to within about one inch of the top. The flames of two torches, one on each side, were directed against the face of the pulley to keep the solder hot.

After spreading acid over the end rings and bars, we set the rotor on the hub of the pulley, as shown; left it there long enough for parts being soldered to become thoroughly heated, about one minute; then withdrew and allowed it to drip before it cooled. The same process was applied to the other end of the rotor. This procedure resulted in an excellent job of soldering. Concern was felt that the "balance" of the rotor might be changed so as to require rebalancing, but we decided to try it first, so the machine was reassembled and tested for speed and vibration and the speed found just where it belonged—1800 r.p.m., with practically no vibration or heating.

Dover, N. H. S. M. HODSDON.

Zeolite Is Porous

ON PAGE 482 of the April 15 issue, I note that W. J. Hughes makes the statement that there is a lot of bunk in regard to the porosity of zeolite and that there is no such thing as a non-porous zeolite. A simple test will prove that he is right. Some time ago, we were in the market for a water softener and gave considerable attention to the zeolite system; the big talking point of most of the salesmen was that their zeolite was non-porous.

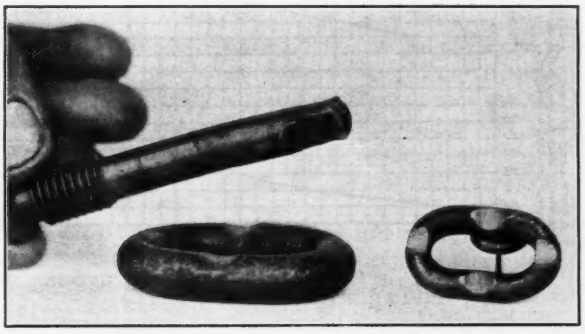
To satisfy myself, I took a small amount of either natural green sand or manufactured synthetic zeolite and placed it in a glass of water. When it was stirred, the water was filled with minute air bubbles. This air was entrapped in the pores of the zeolite and the water forced it out. I then took the same amount of dry lake sand which we know is non-porous, placed it in a glass of water and stirred it and not an air bubble came up. This test proved to me and also to some of the salesmen that zeolite is porous.

In regard to the operation of a zeolite system, we regenerate with a brine solution strong enough to float a hydrometer at eight on a Beaume scale and after the required amount of brine has been passed through the zeolite, we let it set for about 10 or 12 hr. before back washing. By doing this, we have increased the softening capacity of the zeolite from 50,000 gal. of water to 70,000 gal. per regeneration. We regenerate when the water shows 1½ grains of hardness with a standard B. M. soap solution.

Grand Haven, Mich. HARRY J. BADCON.

Chain Links Make Good Straightening Blocks

TWO OLD chain links of different sizes with grooves filed or ground in them, as illustrated, make practical appliances for straightening valve spindles, rods, small

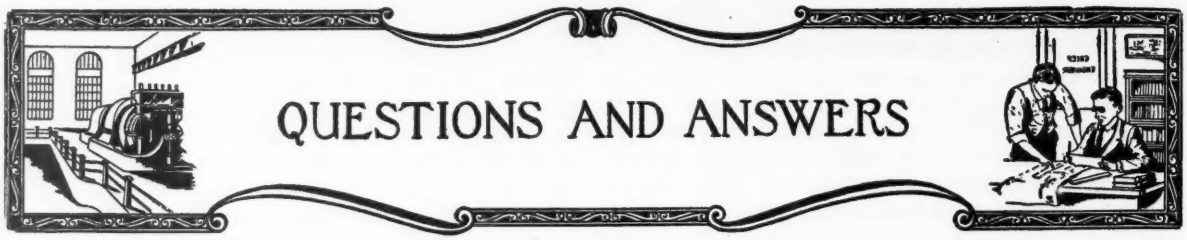


GROOVES FILED IN OLD LINKS PROVIDE READY MEANS FOR STRAIGHTENING RODS

bolts and other parts. By using the links across or lengthwise, long or short bends can readily be hammered out. Particularly useful are such links when a shop with its usual complement of vise, bench or convenient hammering blocks is not available.

Missouri Valley, Iowa. FRANK BENTLEY.

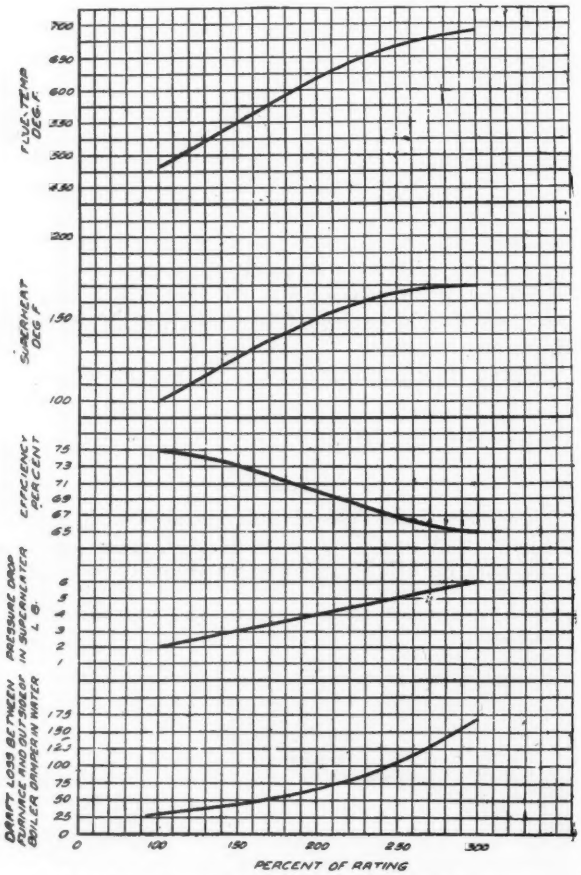
IMPATIENCE, without cause, does not tend to secure good service.



Efficiency Varies with Boiler Rating

WHAT IS the difference in effect on the efficiency of a boiler and on the boiler itself between operating at high rating and at low rating? G. M. R.

A. It is understood that a boiler gives highest efficiency at a definite load. This is ordinarily at the


FLUE TEMP DEG. F
SUPERHEAT DEG F
EFFICIENCY PERCENT
DRAFT LOSS BETWEEN FURNACE AND BOILER BANK IN INCHES OF WATER
PRESSURE DROP IN SUPERHEATER LB.
PERCENT OF RATING

VARIATION OF BOILER PERFORMANCE UNDER DIFFERENT OPERATION RATES

point where the boiler is rated 10 sq. ft. of heating surface per boiler horsepower for water-tube boilers and 12 sq. ft. for return tubular boilers and, although the efficiency curve in modern boilers is quite flat between 90 and 200 per cent rating, if highest overall efficiency is demanded, it is necessary that the boiler be operated at around 100 per cent rating. From the standpoint of economy, however, it has been proved in many plants that boilers should be operated normally around 175 to 200 per cent rating. In a plant where a number of boilers feed into the same header, it is customary to operate all those in the battery at about 200 per cent rating, except one which is used to take the swing of the load, thus maintaining a high overall efficiency of the boiler plant.

Diagram shows changes in boiler efficiency and other characteristics corresponding to different rates of operation. The combined efficiency of boiler and furnace is usually maximum at about 150 per cent rating.

Regarding the effect upon the boiler itself, obviously the life of the boiler is lower and the upkeep cost higher when the boiler is operated at a high rate than when it is operated at a low rate.

Steam Engine Operation

PLEASE GIVE ME information regarding the following:

1. What is the advantage of a compound engine over a simple engine?
2. What is the advantage of having two eccentrics?
3. How is the degree of superheated steam figured? For example, when the steam pressure is 140 lb. gage and it is superheated to 470 deg. F., what is the superheat?
4. Could you run an engine if you had a broken valve or a broken radial arm or a broken pin? How would you do it?
5. If you should see the steam gage registering 140 lb. pressure and your safety valve should blow at 120 lb., would there be any danger by causing the safety valve to blow?
6. What should be the size of the steam pipe for an engine of 4280 hp., using 23 lb. of steam per horsepower per hour?
7. What change must be made to run condensing?

J. B.

A. Advantage in compounding a steam engine occurs when the load is fairly steady and high-pressure steam is used. The amount of saving in steam consumption due to compounding varies. It is due principally to the reduction in the initial condensation and re-evaporation in the cylinder, by keeping the cylinder walls at a more even temperature. A much greater saving can be made at a high pressure than at a low pressure. The speed, terminal pressure, point of cutoff and speed of the engine also have some effect on it.

2. By use of a double eccentric, the operation of the steam valves may be controlled independently of the exhaust valves, therefore better steam distribution and earlier cutoff may be secured than is possible with a single eccentric.

3. To find out the amount of superheat in steam at 140 lb. gage pressure and 470 deg. temperature, we look in our steam tables to find the temperature corresponding to this pressure, which must first be changed to its corresponding absolute pressure by adding 15 lb., or

approximate atmospheric pressure, to the gage pressure. This we find to be 140 + 15 = 155 lb. Consulting steam tables, we find the temperature corresponding to dry and saturated steam at 155 lb. to be 361 deg. Since the steam in the problem actually has a temperature of 470 deg., the amount of superheat is 470 — 361 = 109 deg.

4. If your engine had a sufficiently heavy flywheel and the load was not a lighting load, you could run your engine, if it is a simple one, by disconnecting the end where the break has occurred and operating as a single acting engine. If your engine is cross compound, it may be best to cut out the cylinder on which the break occurred and run it as a simple engine, or it may be operated "three legged" by merely cutting out the end in which the trouble occurred. Such operation would be proper only for emergency operation. The engine should be repaired as soon as possible.

5. There would be no danger in causing a stuck safety valve which is set to blow off at 120 lb. to blow off at 140 lb. It would be the proper thing to do.

6. You give us little data to determine the proper size of pipe, so we must make some assumptions.

Steam pipes at an engine are generally comparatively short, hence friction or loss of pressure is a negligible factor. Assuming the engine to run at 150 lb. pressure and piston speed of about 600 ft. per min., and assuming the steam to be dry and saturated, the area of the steam pipe in square inches would be:

$$A = (W \times S \times 144) \div (V \times 60)$$

Where W = weight of steam per hr.

S = specific volume of steam at 150 lb. pressure.

V = allowable velocity of steam in pipe.

$A = (4280 \times 23 \times 3.012 \times 144) \div (8000 \times 60) =$ 98.5 sq. in. area.

This corresponds to $11\frac{3}{16}$-in. diameter. Therefore an 11-in. diameter pipe would be suitable.

If the steam were superheated, the allowable velocity would be increased in the following proportion.

Degrees of superheat F.	0	50	100	150	200	250
Allowable velocity in ft. per min.....	8000	8500	8950	9450	9900	10450

7. In this question we presume you refer to the changes necessary in the engine when changing from non-condensing to condensing. It is necessary to reset the valves, particularly adjusting the cutoff and compression to the new pressures in the cylinder.

Boiler Construction and Efficiency

PLEASE ANSWER the following questions regarding boilers:

1. If you found a longitudinal seam of a boiler cracked, what should be done?

2. How is provision made for the expansion of tubes in a water-tube boiler?

3. What is meant by boiler efficiency and engine efficiency? M. C.

A. A boiler in which a lap joint crack is discovered should not be repaired but permanently discontinued from service. Several states have laws covering this.

2. In order to provide for the expansion of tubes in a water-tube boiler, one end of the boiler must hang free or the tubes must be of the bent variety.

3. Efficiency has reference to the ratio of the energy output to the energy input, energy being usually expressed in foot-pounds or in British thermal units. In the case of a boiler including its grate, the output is measured by the B.t.u. in the steam generated in a given time and the input by the B.t.u. in the coal fired during the same time. Efficiency = output ÷ input.

Refrigerating System Temperatures

ANSWERS to the following will be appreciated:

1. Where should I place my thermometer in the high-pressure side of my ammonia compressors so as to be sure to have no superheat in the ammonia gases or that the corresponding temperatures should check with the pressure gage?

We are running on an average of 185 lb. head pressure, therefore the temperature corresponding to that pressure, according to my tables, is 95.5 deg. F. I have a thermometer in the discharge line, close to the compressor, which registers 210 deg. F. and the thermometer in the liquor line between the condenser and the ammonia receiver registers 71 deg. F., while the temperature of the cooling water going to the condenser registers 69 deg. F.

2. Is there any way to determine what my head pressure should be from the fact that we get an average of 8 deg. F. rise in temperature in the water entering and leaving the ammonia condensers? It enters at 69 deg. and leaves at 77 deg. F.

3. Where should I place my thermometer in the return line to the compressors; the return line leaving the brine tank passes through a forecooler but has no bypass by the accumulator. I have a 4-in. pipe, 3 ft. long, between the accumulator and a 4-in. cross; a suction line to each of the three compressors connects with this cross. If I should place a thermometer in the suction line before the cross is reached, would not this answer for any or all machines? J. F. W.

A. Place the thermometer just above the stop valve. What you want to determine with this thermometer is whether or not the temperature registered on it corresponds to that of dry and saturated ammonia for the given pressure, as shown in ammonia tables. If the temperature shown on this thermometer is above the temperature corresponding to saturation, superheat would be indicated.

2. The temperature you state (95.5 deg.) is the correct temperature of dry and saturated ammonia at 185 lb. gage pressure. Since the thermometer on the discharge line registers 210 deg. F., it indicates that the piston rings and discharge valves are both leaking and the suction gases are backing up.

The difference between the water entering and discharging from the condenser, namely a rise of only two degrees, is very good. It is usual to allow 3 deg.

Eight degrees rise in temperature in the condenser cooling water represents good operation. It is usual to allow a 10-deg. rise.

You should have a head pressure of about 175 to 177 lb. instead of 185 lb. for the temperature of water you secure. Probably you will find it to be to your advantage to purge the condenser.

3. Place the thermometer in the return line as close as possible to the compressor.

EDITORIAL COMMENT

Obsolescence of Power Plant Equipment

Obsolescence of power plant equipment is becoming, each year, a more important factor to be considered by the man responsible for paying the costs and collecting the profits of the power plant. Not so long ago, depreciation had greater influence than obsolescence on the buying of equipment. Now, however, obsolescence seems to be the more important of the two. The general attitude used to be: Run the equipment until it falls apart, patch it up, then run it some more. Nowadays we realize that patching up, except in emergencies, may cost more than new equipment to do the same work more efficiently.

While it is extremely difficult to formulate a definition of obsolescence that will cover all the factors that influence it, or that will cover all the individual cases to which it applies, it may be said, in general, that obsolescence denotes the unforeseen wiping out or lowering of the value of a given piece of equipment because invention has supplied a better device. It is apparent that the word "better" can refer either to performance, luxury value or almost any other characteristic for which the equipment is bought.

Furthermore, the importance of obsolescence will vary in each individual case. For example, a certain wealthy family in Boston still uses two automobiles that originally cost about $10,000 each in 1912. These cars have been kept in perfect repair and the fact that they look old-fashioned apparently means nothing to the owners. Mechanically they serve the purpose of the owners just as well now as they did in 1912. Then, too, everyone knows that the owners could afford a dozen of the latest models. The average car owner, however, has been skillfully sold on the value of style, beauty and luxury value, in addition to mechanical excellence, hence he feels that his car is obsolete when new models are brought out that look better, although they may serve him no better. This is only one illustration of the way in which obsolescence applies to many of the products we consume, especially to things that are in reality luxuries.

In the power plant, on the other hand, obsolescence is susceptible of a somewhat more rigid interpretation and is less influenced by style, beauty and similar factors. In short, if we assume that a certain piece of power plant equipment has been maintained in the best possible condition, not allowing it to depreciate at all, yet a time will probably come in the course of its life when the superior performance of a new device will justify replacing the old by the new device. In other words, the improved equipment will give a performance sufficiently better than the old to permit a saving greater than the cost of maintaining the old without depreciation.

It appears difficult to predict with certainty how long a given piece of equipment can be operated before it becomes obsolete. Yet, on going further into the matter, it is apparent that, for several years, the curve of power plant efficiency has been a straight line sloping gently upward. It has not been a "stair-step" curve. This is because each new invention, while it may be fundamentally sound, must be applied commercially and it takes a little time to do this. The binary vapor cycle, stage feedwater heating, turbulent firing of pulverized coal, water-cooled furnaces—these do not revolutionize power plant practice in a few weeks.

For this reason, we have wondered whether or not any analysis of power plant obsolescence is possible or desirable. Suppose, for example, we discovered that, somewhere about the tenth year of the life of a particular type of equipment, it was practically certain that it would become obsolete. Would this exert an important influence on the design and construction of the equipment itself, on the amount of depreciation that could be allowed on it, on the design of the entire power station containing it?

Just how such an analysis could be made is not clear. It would be a job for trade associations of manufacturers, for national engineering societies, for the National Electric Light Association or similar agencies.

At all events, even if no definite conclusions could be reached, such an analysis would yield data of inestimable value to plant designers and manufacturers. It would seem that such a project should be undertaken by someone. The fact remains that obsolescence as well as depreciation must be given full consideration nowadays in designing and operating power plants and that data are badly needed on which to base obsolescence allowances.

Production—Consumption—Teamwork

For all members of society, good business is desirable and advantageous. Good business is: plentiful production of useful and durable articles so that management and workers are fully employed and have money to buy the products of their own and others' activity; adequate consumption so that the products of farm, mine and factory will be quickly put to use for temporary or permanent welfare of human beings; teamwork or co-operation so that production and consumption will be balanced and each worker receive his fair share of the products of industry.

This sounds like an industrial paradise but is it an impossibility?

What and how much to produce must always be matters of judgment, a responsibility of those in charge

of industry, since production comes well in advance of consumption. Study of past records, the needs and desires of buyers and their tendencies in buying gives a basis for forecasting future consumption. Only in the case of a new article, not previously marketed, is there occasion to "go it blind" and, in such a case, wisdom dictates conservatism in estimating sales possibilities.

Consumption can be increased, to the point where all who can profitably use an article are supplied, by publicity—making known the merits and uses of the article and its value in adding to happiness or to economic welfare. Here, again, judgment enters as to the best means of publicity and a study of past experience, of the possible market and of the most effective way to reach it is important as a basis for wise action.

Teamwork is, however, fundamental in both production and consumption and of utmost importance in securing and maintaining proper balance, as well as just distribution of returns from industry. It involves gathering and dissemination of data as to past production and sales, as to costs of manufacture, as to available purchasing power, as to results of marketing methods, as to reasonable returns to capital, management and workers. It means co-operation of individuals in groups, of groups in associations and of associations with each other and with government agencies. Without teamwork, no adequate data can be gathered, no balance achieved of production to possible markets, no just distribution of returns among those who work in production and marketing of products.

Where does this lead? Co-operation means combined action for the best interests of all concerned. It is directly opposed to individual action of each in his own selfish interest, regardless of the rights or interests of others. In teamwork, whether business or baseball, success of the organization is the object.

So far, production has been stressed in industry. More goods, cheaper goods, better methods—without, in many cases, adequate consideration of the market possibilities and limits. As a consequence, excessive effort to create markets and disappointment with returns. On the other hand, juggling of marketing distribution and finance, so that returns are not fairly apportioned.

In the desired co-operation, management, finance, labor and government would be organized and would work together with the purpose of avoiding dull seasons, overproduction, unjustified wages, salaries or profits, either too high or too low, and securing fair treatment of individuals in each group. President Lewis E. Pierson of the Chamber of Commerce of the United States voiced his belief, in his recent address at Washington, that we are heading toward such co-operation. Judge Edwin B. Parker emphasized the duty of repudiating those who violate the principles of sound business conduct and betray their private or public trusts. He said that stockholders should interest themselves as much in the proper conduct of their officials as in the return in dividends, if they wish to maintain the value of their investments. To promote enduring prosperity, there must be teamwork between all branches of society and between all groups.

To this end, business men, farmers, factory workers, bankers, government officials and employes need to think of the welfare of all rather than striving for unjust advantage. This sounds idealistic but, unless it can be achieved or approximated, are we not in the position of a family, each member of which seeks his own selfish advantage and pleasure instead of considering the welfare of others and of the whole group?

"....for a Period of Five Years After Date of Completion"

Perhaps no other phrase could so graphically depict the progress of engineering, the growing responsibility commercial organizations feel toward their clients and the increased assurance and dependability that they can place on their own workmanship, design and materials and those of co-operating firms.

For a number of years past, manufacturers have used a more or less standardized warranty applicable to machinery and equipment of their own manufacture covering defects in material and workmanship under normal use and service for a period of not more than one year after date of shipment. For building and engineering construction, the usual guarantee is for a period of one year.

Incorporation of the longer guarantee as a regular policy is an important step forward. This increased time period was recently announced by an American firm of construction engineers engaged in work all over the world.

Every lump sum contract now undertaken by this company on plans and specifications which they have prepared or approved for guarantees, will include this clause, "The builder guarantees the work against defective workmanship and material for a period of five years after date of completion." Regular inspections of at least once a year are included in the guarantee and any defects found within the five-year period will supposedly be taken care of and adjusted promptly.

The promptness and degree of adjustment will, of course, depend upon the honesty and integrity of the company making the guarantee. As with all guarantees, the value of the agreement to the customer depends more upon the sincerity and integrity of the guarantor than it does upon the actual phraseology of the agreement.

Nevertheless the forward step of this firm of engineers is important as pointing out the lengths to which they feel justified in going and the reliance they place on their own and manufacturer's products. Naturally, being engaged in design and construction of engineering and industrial structures, the materials they use are manufactured by others and their guarantee must be based on specific guarantees by others. Thus their faith is based not entirely on their own work but also on the integrity of our American business structure.

ONLY FOUR decades ago the first central station service plant in the United States served 59 customers. Today there are about 5000 operating companies which serve approximately 18,000 communities and about 20,000,000 light and power customers.

MOST PEOPLE would succeed in small things if they were not troubled with great ambitions.—Longfellow.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

Centralized Control for Heating Systems

MODERN HEATING systems are often designed with the radiation surfaces sectionalized so that varying amounts of steam can be supplied to the sections depending on the local temperature variations in different parts of the building. To control from a central point the throttle valves on the supply mains of the sections, an electrically operated control system has been developed by Webster Tallmadge & Co., Inc., New York City.

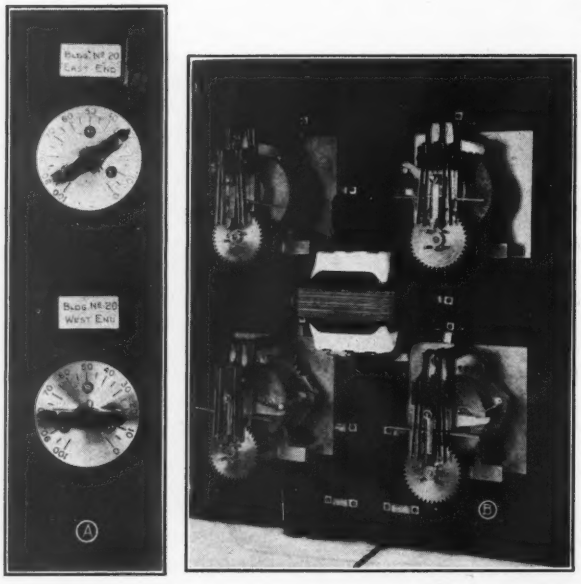


FIG. 1. A—FRONT OF PANEL, SHOWING CONTROL HANDLES AND DIALS. B—MECHANISM ON REAR OF PANEL, ACTUATED BY HANDLE, SENDS ELECTRICAL IMPULSES TO OPERATE VALVE

This system is designed so that all operations are controlled from the panel shown in Fig. 1, which might be placed in the chief engineer's office. The dials are graduated in per cent of the normal steam supply through the respective mains. When the handle is moved over the dial, therefore, say to 60, the corresponding steam valve will be closed or opened until only 60 per cent of the normal steam supply is delivered to that section.

To accomplish this, devices are used as shown in Fig. 1B, the back of the panel, and in Fig. 2, the valve operating mechanism. Referring to Fig. 1B, the handle on the front turns a cogged wheel, rotation of which winds a spring attached to it. When rotation stops, a lever is released that allows the spring to unwind, causing an escapement wheel to revolve. As it does so, posts on the escapement wheel engage with a contact lever and send a series of electrical impulses to the receiving end to operate the valve in one direction. To operate it in the other direction, the control handle is moved the opposite way and the same operation takes place, involving the use of a second contact lever.

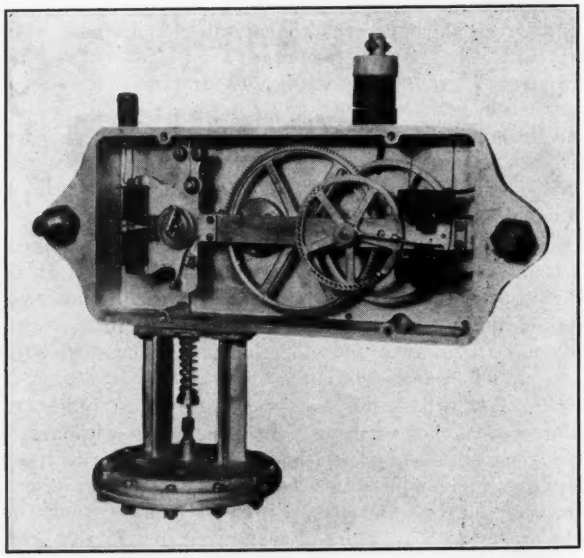


FIG. 2. THIS MECHANISM, ACTUATED BY ELECTRICAL IMPULSES FROM CONTROL PANEL, OPERATES THE VALVE

At the receiving end, Fig. 2, the electrical impulses energize either of the two magnets shown at the left of the case, depending on whether the valve is to open or close. As the armature of the magnet is attracted to the coil, a pawl on the end of the armature engages notches in a wheel and through a system of cams, levers and gears, the valve-stem motor is operated a short time, to correspond with each of the received impulses. To control this motion and secure just the right setting of the valve for a given movement of the control handle, a diaphragm is connected in such a way that the pressure on the low-pressure side of the regulating valve determines the amount it must open or close to admit the proper amount of steam. A limit switch prevents the motor from injuring the valve. The motor, mounted on the back of the controller, drives the valve stem through a gear train, a spring clutch being provided between stem and gears for additional protection.

Temperature Controller for Automatic Regulation

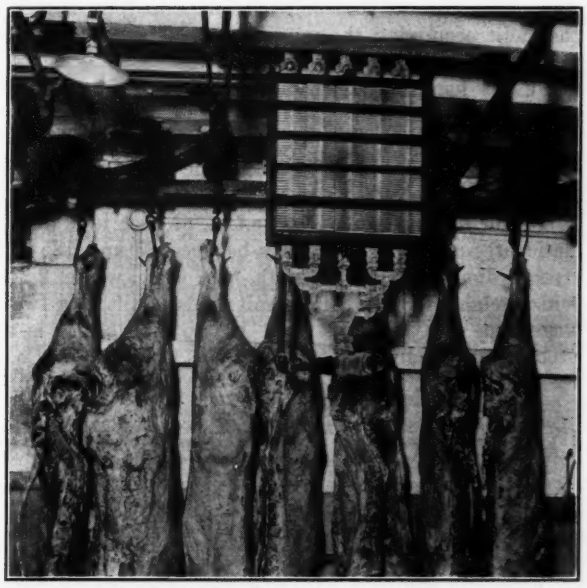
TO MEET the demand for a self-contained automatic controller of simplicity, high sensitiveness and low cost, a new type of temperature controller is announced by American Schaeffer & Budenberg Corp., 338 Berry St., Brooklyn, N. Y. By combining a flexible bellows of new design with an operating spring of exceptionally large diameter and great length, a mechanism has been designed to hold temperatures constant within limits of 1 deg. F. without manual attention.

TEMPERATURE CONTROLLER CAN BE SET BY VARYING VALVE SPRING TENSION

This instrument is made in a number of standard temperature ranges and can be set as desired. The setting point may be adjusted by turning a nut, which varies the tension of the valve spring and thus determines the pressure required to expand the bellows. A scale, shown in the picture, enables a given adjustment to be repeated after it has been changed. The safety device, designed to guard against damage to the bellows from over pressure caused by accidental overheating, is in the form of a spring placed between the upper and lower parts of the valve stem. If the pressure in the bellows increases after it has completed its stroke and the valve is seated, this spring will be compressed, thus allowing further expansion. The controller is designed particularly for hot water service tanks, water heaters, cookers and kettles or wherever a simple controller is required for close regulation.

Thermal Unit Designed for Heating or Cooling

DESIGN of a unit heater to be used either for heating or cooling has been carried out in the Thermal Unit, shown herewith. The heating element is of a cast aluminum alloy with extended surface and the same element is used for heating and cooling. It is designed for pressures up to 250 lb. per sq. in. Standard units are 3, 5 or 7 sections wide, depending on the capacity desired, which varies also with the fan speed. Fans are driven by universal motors and louvers are provided to deflect the air stream. Heating capacities range from



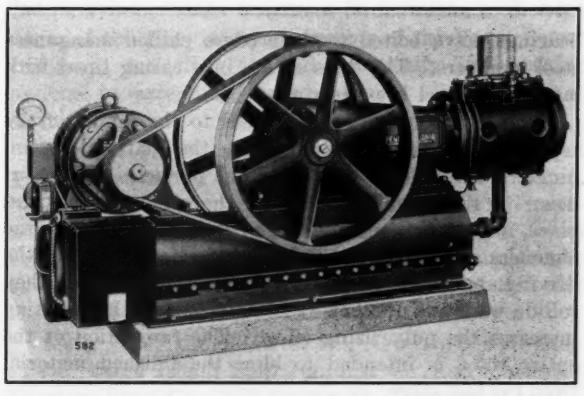
THERMAL UNIT INSTALLED IN COOLER ROOM OF MEAT PACKING PLANT

equivalent of 390 sq. ft. of direct radiation to 1230 sq. ft., depending on pressures and temperatures.

In the installation shown herewith, the Thermal Unit is being employed for refrigeration in the cooler room of M. Krooth & Co., packers. Operating on direct expansion, it maintains an average room temperature of 34 deg. Before it was installed, condensation dripped from the ceiling onto the beef but with the unit operating, the room is now dry and cool, it is stated. Thermal Unit is a product of Thermal Unit Co., Chicago, Ill.

Pennsylvania Semi-Portable Single-Stage Compressor

SINCE small industries whose air requirements are comparatively limited often require small compressors, the unit shown, a semi-portable, single-stage, double-acting, multiple-belt-driven air compressor, completely self-contained, has been placed on the market. Motor, starter, multiple-belt drive, receiver, filter start and



COMPRESSOR, MOTOR AND ALL ACCESSORIES ARE MOUNTED COMPACTLY, REQUIRING ONLY AIR, WATER AND POWER CONNECTIONS

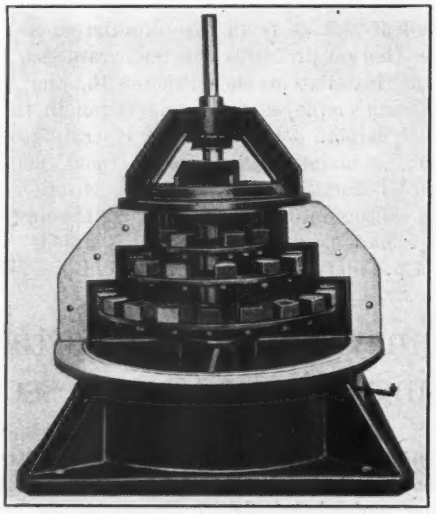
stop control are all assembled in place to form a compact unit occupying the minimum of floor space. Air cylinder and all working parts are automatically lubricated and hopper cooling tank can be furnished with the compressor if desired.

Compressor is equipped with air-cushioned valves and is driven by a 10-hp. high-torque motor operating the compressor at 400 r.p.m.

Piston displacement is 65 c.f.m. of free air; automatic pressure control operates between 85 and 125 lb. Overall dimensions are: length, 6 ft. 6 in.; width, 2 ft. 4 in.; weight, 1380 lb. This unit is also built in a two-stage type for pressures from 125 to 250 lb. It is a product of Pennsylvania Pump & Compressor Co., Easton, Pa.

Centripact Pulverizer Employs Both Impact and Attrition

FOR PULVERIZING various types of ore and coal, the Centripact pulverizer shown here was designed by a mining engineer. Its operation depends on both impact and attrition. Three or more horizontal mild



INTERIOR OF CENTRIPACT PULVERIZER SHOWING DISC AND HAMMER ARRANGEMENT

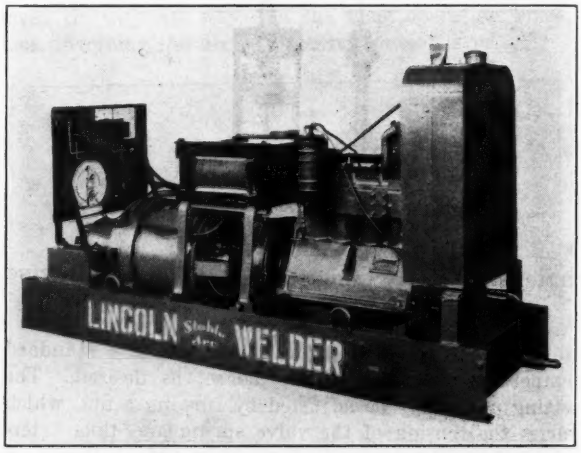
steel discs, mounted on a vertical shaft running in ball bearings, have bolted to their edges chilled manganese steel hammers. The discs rotate in a casing lined with manganese steel breaker rings.

Material to be pulverized feeds to the center of the top disc, the hammer blows cause the material to impinge on the breaker rings, the fine particles are drawn down to the second disc where the same action takes place, it is stated, and the large particles rebound to the hammers until they are pulverized. Meanwhile, in the driving and rebounding of the particles of material, they collide with one another, it is claimed and the attrition increases the pulverizing effect. The fan action of the entire rotor is intended to blow the finished material from the last stage.

This pulverizer, distributed by George F. Pettinos, Philadelphia, Pa., is designed to pulverize coal, limestone, clay, abrasives, iron ore or chips, flint rock, quartz and other materials fine enough to pass from 20 to 350-mesh, depending on speed, which may range from 1000 to 2600 r.p.m. and on clearance of hammers. Size B is made to pulverize 1 t. to 5 t. per hr. and size C to pulverize 2 t. to 7 t. per hr., depending on several factors. The unit can be arranged for driving from a motor by belt, texrope drive or worm gear or by a vertical steam turbine.

Portable Welder Driven by Gasoline Engine

INCREASING use of welding in construction work has led The Lincoln Electric Co. of Cleveland, Ohio, to announce a new model of the "Stable-Arc" welder, known as the S-1960 Model. This unit has a rating of 200 amp., according to N. E. M. A. standards,



WELDING GENERATOR, ENGINE AND STEEL SWITCHBOARD ARE MOUNTED ON WELDED STEEL BASE

with a current range for welding duty of from 50 to 300 amp. and operates at 1500 r.p.m. Motive power is provided by a four-cylinder Continental Red Seal engine, type H-9. Welding generator and engine are mounted on a structural base welded into a solid piece of steel. The whole unit weighs 1580 lb. and is 76 in. long and 25 in. wide.

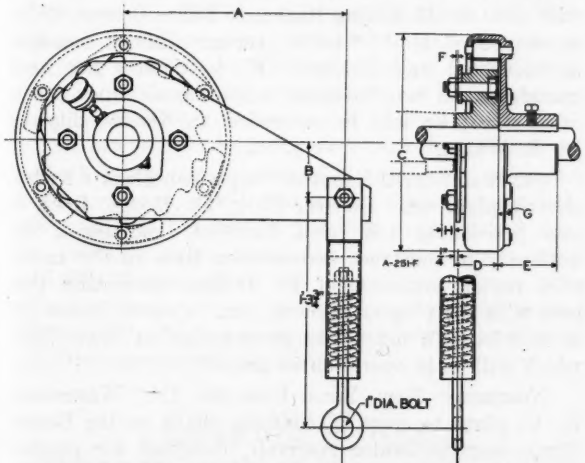
The generator is also constructed of steel to reduce weight and possibility of breakage. The complete magnetic circuit of the generator is of laminated steel, to increase the stability of the arc. This is highly desirable in work for which this unit was brought out, because many times welding must be done in a vertical plane and frequently overhead. A steel switchboard is also provided in place of the usual slate or composition board.

ALABAMA POWER CO., Birmingham, Ala., has approved plans for the proposed Warrior Steam Plant on the Warrior River near Gorgas, Ala., and will proceed with construction at an early date. The plant is to have an initial capacity of 80,000 hp., to be increased later to an ultimate capacity of 320,000 hp. Installation of equipment is scheduled to begin early in the fall and the plant is expected to be ready for service in May, 1929.

Safety Lock for Conveying Equipment

FOR LARGE ELEVATORS, pivoted bucket carriers, belt conveyors and similar equipment where the load on the vertical lift might cause a backward run of the equipment with interruption of power, the Jeffrey Manufacturing Co., Columbus, Ohio, has developed a silent ratchet safety lock.

The accompanying drawing shows how one of the six pawls grouped around the ratchet is always in position to grip a ratchet tooth. The housing itself is bolted to the counter shaft and turns with it when the power



RATCHET SAFETY LOCK DESIGNED TO PREVENT CONVEYOR FROM RUNNING BACK IF POWER IS SHUT OFF

is on. Pawls are spaced around the ratchet teeth so that the maximum backward motion of the ratchet is no more than one-third of the distance between the teeth (less than one inch, even on the largest stone elevator).

Another feature of the safety lock is the spring attachment to take the jar out of the operation of the mechanism. This spring acts as a snubber on the arm bolted to the ratchet and when the load descends on the pawls the spiral spring takes most of the force of the blow.

This Jeffrey silent ratchet safety lock can be fitted on elevators and inclined conveyors now in use as well as on new installations.

News Notes

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS will hold its 44th summer convention from June 25 to 29 at Denver, Colo., with headquarters at the Cosmopolitan Hotel. Among the subjects of the technical papers will be investigations of surges on transmission lines, control of feeders for electrified railways including operation of high-speed circuit breakers, alternating-current elevator motors, electric welding of pipe lines, high-frequency supervisory control, extinction of alternating-current arcs, telephone communication and geophysical methods of prospecting for metals and oil. Advances of the past year in all phases of electricity will be covered in fifteen annual reports of the Institute's technical committees. A tour of Yellowstone Park and other places will be taken following the convention. Details of the tour are published in the May issue of the A. I. E. E. Journal. Complete program and further convention details can be obtained from the secretary of the A. I. E. E., 33 West 39th St., New York, and hotel reservations should be addressed to A. I. E. E. Hotel Committee, Cosmopolitan Hotel, Denver, Colo.

NATIONAL INDUSTRIAL CONFERENCE BOARD, at its 12th annual meeting at the Hotel Astor, New York, re-elected Loyall A. Osborne, president of Westinghouse Electric International Co., as chairman of the board for the ensuing year. Magnus W. Alexander continues as president and chief executive of the organization.

ADMINISTRATIVE BOARD of the American Engineering Council, 29 W. 39th St., New York City, at its recent meeting in Milwaukee, Wis., endorsed the creation of a commission of engineers, as proposed in the Douglas Bill, to investigate the physical problems connected with flood control and development of the Colorado River.

FROM THE EAST PITTSBURGH WORKS of Westinghouse Electric & Manufacturing Co. the first light-weight, oil-electric, switching locomotive to be built in America has been shipped to New York, where it will be put in service on the Long Island Railroad. This locomotive of 600-hp. capacity weighs 85 t. and is designed to burn low grade fuel oil. It will be used on the Long Island Railroad for switching purposes, making it unnecessary to operate steam engines over sidings which have no third rail or trolley wire. The locomotive consists of two cabs operated as a single unit but capable of individual service if desired. It is geared for a maximum speed of 34 mi. an hour. Each cab contains a 300-hp., 6-cylinder oil engine driving a 210-kw. electric generator that furnishes power to two traction motors. The generator supplies direct current at 750 v. at normal high speed. The engine and electrical equipment were built by Westinghouse Electric and Manufacturing Co., and the mechanical parts were supplied by the Baldwin Locomotive Co.

PUGET SOUND POWER AND LIGHT CO., Seattle, Wash., which furnishes electricity to the state of Washington and to the Northwest, has been awarded the Charles A. Coffin Foundation gold medal for its outstanding achievements during 1927. The award was announced on June 6 by H. T. Sands, president of the National Electric Light Association in convention at Atlantic City. It is the fifth annual award of the medal, made possible through the creation of the Charles A. Coffin Foundation in 1922. President Sands spoke in glowing terms of the many accomplishments of the Puget Sound company, declaring "it had practically left nothing undone in extending its business in all branches of activity."

WALTER KIDDE, acting chairman of the Board of Trustees of Stevens Institute of Technology at Hoboken, N. J., announces that the board has created a new position of vice-president of the Institute and that James Creese, now general secretary of the American-Scandinavian Foundation, has been elected to fill it and also to serve as treasurer of the Institute.

AMES PUMP CO., 90 West St., New York, a division of the Staten Island Ship Building Co., has appointed Yeomans Bros. Co., 1432 Dayton St., Chicago, to handle its products in that district.

American Institute of Steel Construction, Inc., 285 Madison Ave., New York City, announces that V. Gilmore Iden has been appointed to succeed William H. Page in charge of the Bureau of Public Relations and that A. T. North, who has resigned from the Bureau of Architectural Relations, will be succeeded by F. H. Frankland.

Sanford B. Belden, vice-president of The Jeffrey Manufacturing Co., Columbus, Ohio, died at the Hotel Chatham, New York City, on May 15. Mr. Belden had been in the service of the company since 1896, shortly after his graduation from the School of Mines of the Ohio State University.

Announcement is made that on April 1, 1928, Alfred Iddles was elected vice-president of Day & Zimmermann Engineering & Construction Co., Philadelphia, Pa.

Interest of Edward F. Wilson in the partnership of Castle & Wilson, 1601 Arrott Bldg., Pittsburgh, Pa., has been purchased by the senior member of the firm, James T. Castle, who will continue the business as heretofore.

Ashland Division of the American Rolling Mill Co. has ordered three 300-hp. oil-electric locomotives to be built jointly by Ingersoll-Rand Co., General Electric Co. and American Locomotive Co.

Magnetic Manufacturing Co., Milwaukee, Wis., has appointed J. H. Phinney as exclusive representative for Eastern Michigan with headquarters at 420 U. S. Mortgage Bldg., Detroit, Mich.

F. C. Allen, Jr., founder and former president of Allen & Billmyre Co., Inc., has recently severed his connection with that organization. He is now president of Allen Air Appliance Co., Inc., making his headquarters at the New York office of this company in the Grand Central Terminal Building. The main office and plant of the latter company is at Glens Falls, New York.

Announcement has been made by Harry J. Steinbreder, president of the Fulton Iron Works, St. Louis, Mo., that this company has purchased the Foos Engine Co., of Springfield, Ohio. The purpose of the combination, it is stated, is to give the company a complete line of Diesel engines ranging from 60 to 2000 hp. and a line of gas engines.

E. W. Nick, president of the Northern Equipment Co., Erie, Pa., has returned to America after an absence of several months in Europe. Mr. Nick visited the various European factories where Copes boiler feed water regulators are made, also representatives in practically all of the countries of Western Europe.

Announcement is made that the University of Chicago, Chicago, Ill., plans to build a new heating plant adjacent to the Illinois Central tracks at 61st St., to serve the new University buildings to be erected.

Authority to construct and operate a 6000-v. transmission line from Clinton, DeWitt County, Ill., to Deland, in Piatt County, has been granted the Illinois Power and Light Corp. by the Illinois commerce commission. The commission also granted permit to operate distribution systems in Lanes, Creek township, DeWitt County, authorized the Central Illinois Power Service to purchase the Elizabethtown Power and Light Co. for $8,681.50 and granted the Public Service Co. of Northern Illinois authority to operate distribution systems in Kane, Lake, McHenry and Will counties.

The Dampney Co. of America, Hyde Park, Boston, Mass., has appointed C. J. Hunter, Bourse Bldg., Philadelphia, Pa., as its district sales manager.

Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa., announces that its products will be handled in Toledo, Ohio, and vicinity by the Builders & Industrial Supply Co., 4090 Detroit St., Toledo, Ohio.

Elliott Co., Jeannette, Pa., has opened a new district office at 512 Mining Exchange Bldg., Denver, Colo., in charge of M. C. Sickels, former district manager in Cleveland and Chicago. F. A. Calmus has been transferred to San Francisco, where he will open a new sales office; he will be succeeded at Kansas City by W. E. Widau.

Central States Electric Co., which plans a hydroelectric plant near Dolliver Park, Ft. Dodge, Iowa, is also petitioning the Iowa Railroad Commission for authority to construct transmission lines in the industrial region southeast of Ft. Dodge, connecting that area with the proposed power dam. Central States Co. is completing a big power development at Iowa Falls, which will be in operation in August.

Northern New York Utilities Co., Watertown, N. Y., plans to erect a 12,000-hp. plant on the Beaver River near Stillwater reservoir, designed for possible expansion to 24,000 hp.

According to an announcement by Halford Erickson, vice-president of H. M. Byllesby & Co., the Oklahoma Gas & Electric Co., Oklahoma City, has purchased the 13,000-kw. Belle Isle generating station of the Oklahoma Railway Co., in Oklahoma City.

Tennessee Eastern Power Co., Johnson City, Tenn., operated by Henry L. Doherty & Co., has applied to the State Railroad & Public Utilities Commission for permission to build a hydro-electric plant of 48,000-hp. capacity on the Holston River.

Pacific Gas & Electric Co. has filed application for a dam on Mokelumne River, 50 mi. northeast of Jackson, to be 300 ft. high, 1300 ft. long at the top and to store 130,000 acre feet of water. Water will be turned back above Lancha Plana dam after use in an 11,000-hp. plant at Salt Springs, passing through tunnels to Tiger Creek and a 67,000-hp. plant on Tiger Creek.

Total production of soft coal during the week ended May 5, including lignite and coal coked at the mines, is estimated at 8,183,000 net tons. This is a decrease of 0.1 per cent over the output of the preceding week. The total production of anthracite during the week ended May 5 is estimated at 1,825,000 net tons, a decrease of 3.4 per cent from the output of the preceding week.

H. D. Savage, president of the Dry Quenching Equipment Corporation, announces the election of D. W. Wilson as vice president and general manager. Mr. Wilson has been active in the work of the Carbonization Committee of the American Gas Association, has previously been with the Wilputte Coke Oven Corpora-

tion and the Iroquois Gas Corporation and was assistant professor of chemical engineering at the Massachusetts Institute of Technology.

Dry quenching was originally developed by Sulzer Brothers, Winterthur, Switzerland, as a means of quenching the coke produced by by-product coke ovens and gas retorts in such a way as to put to useful work a large part of the sensible heat content of the coke. Its general use would have great economic significance, since it would result in the recovery of large quantities of heat which are now released to the atmosphere.

As shown by the annual report of the Westinghouse Electric & Manufacturing Co., issued recently, the sales of the company for the year ending March 31, 1928, were, in round numbers, $175,000,000; the net manufacturing profit was $14,000,000; the net income available for dividends was $15,600,000; and the earnings per share of stock (preferred and common) were $6.57, or 13.4 per cent. Dividends were paid during the year on both stocks at the rate of 8 per cent per annum or $4 per share of $50 par value. These figures indicate a slight decrease in business as compared with the previous year, when the annual sales totalled $185,500,000 and $6.80 was earned per share. The balance sheet shows current assets aggregating $122,000,000, which is more than eight times the current liabilities aggregating $15,000,000.

Catalog Notes

To make the essential principles of first aid and the prone pressure method of resuscitation in case of gas poisoning, electric shock and drowning conveniently available, American Gas Assn. and N. E. L. A. have published an illustrated booklet giving the standard procedure as adopted by a conference of eleven national organizations. Copies may be secured at 10c each (reduction for large quantities) from the National Electric Light Assn., 420 Lexington Ave., New York City.

Up-River Pumping Station at Spokane, Wash., is described in a leaflet which explains the system of water supply from artesian wells handling 44,000,000 gal. a day against head of 228 to 398 ft. Leaflet is now being distributed by De Laval Steam Turbine Co., Trenton, N. J.

Suggestions for the writing of specifiations for evaporators, piping, pulverized fuel equipment and coal handling equipment are given in a serial report, Publication No. 78-48, issued by National Electric Light Association, 420 Lexington Ave., New York City.

Results obtained by the use of Wing forced draft blowers in hand-fired and stokered plants are discussed in an illustrated 18-page bulletin sent out by L. J. Wing Mfg. Co., 154 W. 14th St., New York City.

Gasoline-operated locomotive cranes are described in detail, together with discussion of their application, in bulletin No. 56, a recent publication of Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago, Ill.

Charts, Formulas and Simple Rules for the use of persons interested in refractory lining are given in a loose-leaf bulletin by Crescent Refractories Co., Curwensville, Pa.

Power Plant Deaerators of the vacuum, atmospheric and pressure types are described and illustrated in a 16-page bulletin, No. N-8 recently published by Elliott Co., Jeannette, Pa. The company is also publishing bulletin N-9 describing Elliott Desuperheaters, of the cartridge type; Bulletin S-8, describing double automatic triple duty valves and bulletins H-3, H-4, and H-5, describing various types of small turbines for mechanical draft.

Murray-Standard turbines are described and illustrated in Bulletin T-100 issued by the Murray Iron Works Co., Burlington, Ia.

High-Duty magnetic clutches as applied to various types of power drives are the subject of Bulletin No. 72, just published by Magnetic Mfg. Co., Milwaukee, Wis.

In a circular of the Brown Instrument Co., Wayne and Roberts Ave., Philadelphia, Pa., are illustrated the various models of the Brown electric flow meter as well as the features of construction.

Parker tube couplings are described in a recent bulletin by The Parker Appliance Co., 10320 Berea Rd., Cleveland, Ohio.

Frick Co., Waynesboro, Pa., describes in bulletin No. 147-A its direct drive refrigerating units for small individual installations and applications of the unit. Details are given in bulletin No. 102-A.

Desuperheaters of the spray type and the surface absorption type, together with advantages of desuperheated steam for certain types of power plant equipment, are discussed in Bulletin No. 6-D by Schutte & Koerting Co., Philadelphia, Pa.

Herringbone gears are described in a 24-page booklet, Catalog No. 36, recently issued by the W. A. Jones Fdry. & Machine Co., 4401-51 W. Roosevelt Rd., Chicago, Ill.

Powdered Coal for Fuel Efficiency is the title of Bulletin No. 9, describing the Grindle unit pulverizer and illustrating applications of it. This has just been issued by Grindle Fuel Equipment Co., Harvey, Ill.

Insuring Dependable Properties in grey iron castings by the use of nickel is the subject discussed in a four-page folder sent out by International Nickel Co., 67 Wall St., New York City.

Detailed description of the construction of the Atrita unit pulverizer and the new Riley flare type burner, together with several line drawings of actual installations, are given in a recent 28-page well-illustrated catalog sent out by the Riley Stoker Corp., 9 Neponset St., Worcester, Mass.

Details in which requirements of the A. S. M. E. code for boilers are exceeded on the side of safety in construction of Ladd and Heine boilers are given in the April issue, No. 17, of The Safety Valve, published by International Combustion Engineering Corp., 200 Madison Ave., New York, N. Y. Copies will be sent on request directed to the corporation.

Dust Recovery & Conveying Co., Cleveland, Ohio, has just issued bulletin No. 3, revised, containing a discussion by David J. Price of the U. S. Department of Agriculture on dust hazards.

Power Plant Construction News

Ariz., Phoenix—The Salt Water Valley Water Users' Association has approved a fund of $4,100,000, for construction of Stewart Mountain power dam, power station and electrification work on system. C. C. Cragin, superintendent, will be in charge of the project.

Ark., Mulberry—The Common Council is considering the installation of pumping machinery and auxiliary equipment in connection with proposed municipal waterworks and sewage disposal plant. Dickinson & White, Boyle Building, Little Rock, Ark., are engineers.

Calif., Norco—The North Corona Land Co., 528 South Hill Street, Los Angeles, has plans in progress for a one-story steam-operated electric power plant at its properties at Norco, to be 67 by 110 ft., reported to cost $150,000, of which approximately $100,000 will be expended for equipment.

Calif., San Jose—The Union Ice Co., 354 Pine Street, San Francisco, will soon begin construction of one-story ice-manufacturing plant, 204 by 450 ft., on Wilson Avenue, to cost close to $200,000 with equipment.

Colo., Durango—W. L. Soens, Durango, and associates are planning the construction of a hydroelectric power plant for service at Bayfield, Ignacio and vicinity. Entire project is reported to cost in excess of $175,000 with transmission lines.

Fla., Haines City—The Gentile Brothers Packing Co. plans installation of cold storage and refrigerating plant in proposed new fruit canning factory on local site, entire project to cost approximately $100,000.

Fla., Tampa—The Gulf Fertilizer Co., Thirty-sixth Street, will install power equipment in a new plant unit on local site estimated to cost close to $175,000.

Ga., Barnesville—The Common Council plans installation of pumping plant in connection with proposed 500,000-gal. capacity filtration plant for municipal waterworks. Wiedeman & Singleton, Candler Building, Atlanta, Ga., are engineers.

Ill., Oglesby—The Marquette Cement Mfg. Co., 140 South Dearborn Street, Chicago, will install power equipment in proposed new cement mill unit at this place, reported to cost close to $1,000,000. Richard Moyle, Jr., is company engineer.

Ill., Rockford—The Rockford Metal Specialty Co., Cedar Street, plans installation of power equipment in a new two-story plant unit to cost about $100,000, for which superstructure will soon begin. Peterson & Johnson, Swedish-American Bank Building, are architects.

Iowa, Charles City—The Iowa Public Service Co., Fort Dodge, is planning extensions and improvements in power plant at Charles City, reported to cost about $100,000 with equipment.

Iowa, Waterloo—Deere & Co., Moline, Ill., manufacturers of agricultural machinery, etc., will install power equipment in new six-story branch plant at Waterloo, estimated to cost $200,000.

Kan., Meade—The Pumicite Co., Ambassador Building, St. Louis, Mo., Ray E. Bickren, president, plans installation of power equipment in group of pumice plants to be located at Meade, Wilmore, Fowler, and Stanley, Kan., estimated to cost about $150,000. E. Lee Heidenreich Engineering Co., Central Exchange Building, Kansas City, Mo., are engineers.

La., Buras—Chalona Brothers, Inc., plan the construction of a power plant in connection with a new local packing house and will soon begin work. Entire project will cost close to $40,000.

Md., Baltimore—The Chesapeake Paper Board Co., Key Highway and Baltimore & Ohio Railroad, is said to be planning the construction of a boiler plant at its proposed new local mill to cost about $300,000, for which bids are expected to be asked early in June. Karl A. Lefren, 171 Madison Avenue, New York, is engineer.

Mich., Detroit—The Detroit Macaroni Mfg. Corporation, 3261 Bellevue Avenue, will install power equipment in proposed addition to plant estimated to cost $220,000. T. C. Hughes, 2615 Joy Road, is architect.

Mich., Detroit—Parke, Davis & Co., 2951 Atwater Street, plan the installation of power equipment in a new six-story chemical and drug plant to cost close to $1,000,000. Two similar units will be built at later date to cost a like amount. Albert Kahn, Marquette Building, is architect and engineer.

Miss., Hattiesburg—The Mississippi Power Co., Gulfport, Miss., plans installation of power substation equipment at Hattiesburg and Richton, Miss., and will build new transmission lines in this vicinity, totaling about 45 miles.

Mo., Boonville—The Board of Trustees, Kemper Military School, has plans under way for an addition to the power plant at the institution, including installation of additional equipment. The Henrici-Lowry Engineering Co., Security Building, Kansas City, Mo., is engineer.

Mo., Leeds—The Chevrolet Motor Co., General Motors Building, Detroit, a division of the General Motors Corporation, will install power equipment in a proposed new assembling plant near Leeds. Entire project will cost more than $1,000,000. Albert Kahn, Inc., Marquette Building, Detroit, is engineer.

N. C., Winston-Salem—The P. H. Hanes Knitting Co. has approved plans for construction of a power plant at its local textile mill with initial capacity of 1000 hp.; installation will include two watertube boilers, automatic stokers and accessory apparatus. Mees & Mees, Charlotte, N. C., are engineers.

Neb., Omaha—The Burlington Ice, Refrigeration & Express Co. plans rebuilding of portion of three-story ice and cold storage plant recently destroyed by fire, with loss reported in excess of $50,000.

N. M., Portales—The City Council plans the installation of pumping machinery and auxiliary equipment in connection with extensions in municipal waterworks and proposed sewage disposal plant. Entire project will cost in excess of $70,000.

N. Y., New York—The Board of Trustees, American Museum of Natural History, Columbus Avenue and Seventy-seventh Street, has plans under way for a new power and service station at the institution reported to cost more than $500,000, with equipment. Trowbridge & Livingston, 527 Fifth Avenue, New York, are architects.

Ohio, Lorain—The Ohio Public Service Co. will make extensions and improvements in its local Edgewater steam-operated electric generating plant with installation of additional equipment to increase the capacity 30,000 kw., estimated to cost $450,000. Plans have also been completed for a new power substation. Headquarters of company are in the Hanna Building, Cleveland.

Ohio, Toledo—The Libbey-Owens Sheet Glass Co., Nicholas Building, will install power equipment in a proposed new plant for which plans will be drawn at once. Entire project will cost about $1,200,000. Lockwood, Greene & Co., Hanna Building, Cleveland, are architects and engineers.

Ore., Klamath Falls—The Weyerhaeuser Lumber Co., Tacoma, Wash., plans the installation of power equipment in a proposed new lumber mill near Klamath Falls. Entire project is reported to cost in excess of $500,000 with machinery.

Pa., Danville—The Danville Structural Steel Co. will install power equipment in connection with an expansion and improvement program, including new buildings, reported to cost more than $250,000.

Tenn., Knoxville—The Atlantic Ice & Coal Co., Atlanta, Ga., plans the construction of an electric-operated ice-manufacturing and cold storage plant on West Cumberland Street, Knoxville, to be equipped for ice-making capacity of 100 tons per day, reported to cost in excess of $100,000 with equipment. A. P. Pope is general manager.

Texas, Brownsville—The Valley Bonded Warehouse Co. has plans under way for the construction of a two-story cold storage and refrigerating plant to cost about $200,000, with equipment. J. A. Taylor, 2302 Indiana Street, Houston, Texas, is engineer.

Utah, Salt Lake City—The Royal Crystal Salt Co., I. A. Clayton, Jr., general manager, 1204 East Seventh Street, is said to be planning construction of a power station at its proposed new plant about 12 mi. from the city. Plant machinery will be electric-operated. Entire project will cost more than $300,000.

Va., Richmond—The American Enka Corporation, 114 East Thirty-second Street, New York, recently organized, plans construction of boiler plant at its proposed new rayon mill on James River, near Richmond. Entire project is reported to cost more than $1,000,000.

W. Va., Weirton—The Weirton Steel Co. will install power equipment in connection with an expansion and improvement program at its local steel mills to cost approximately $1,200,000. J. C. Williams is vice president.